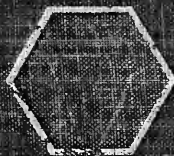
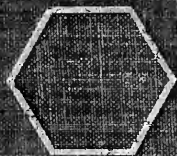


*Introduction to*  
***Psychology***



MUNN

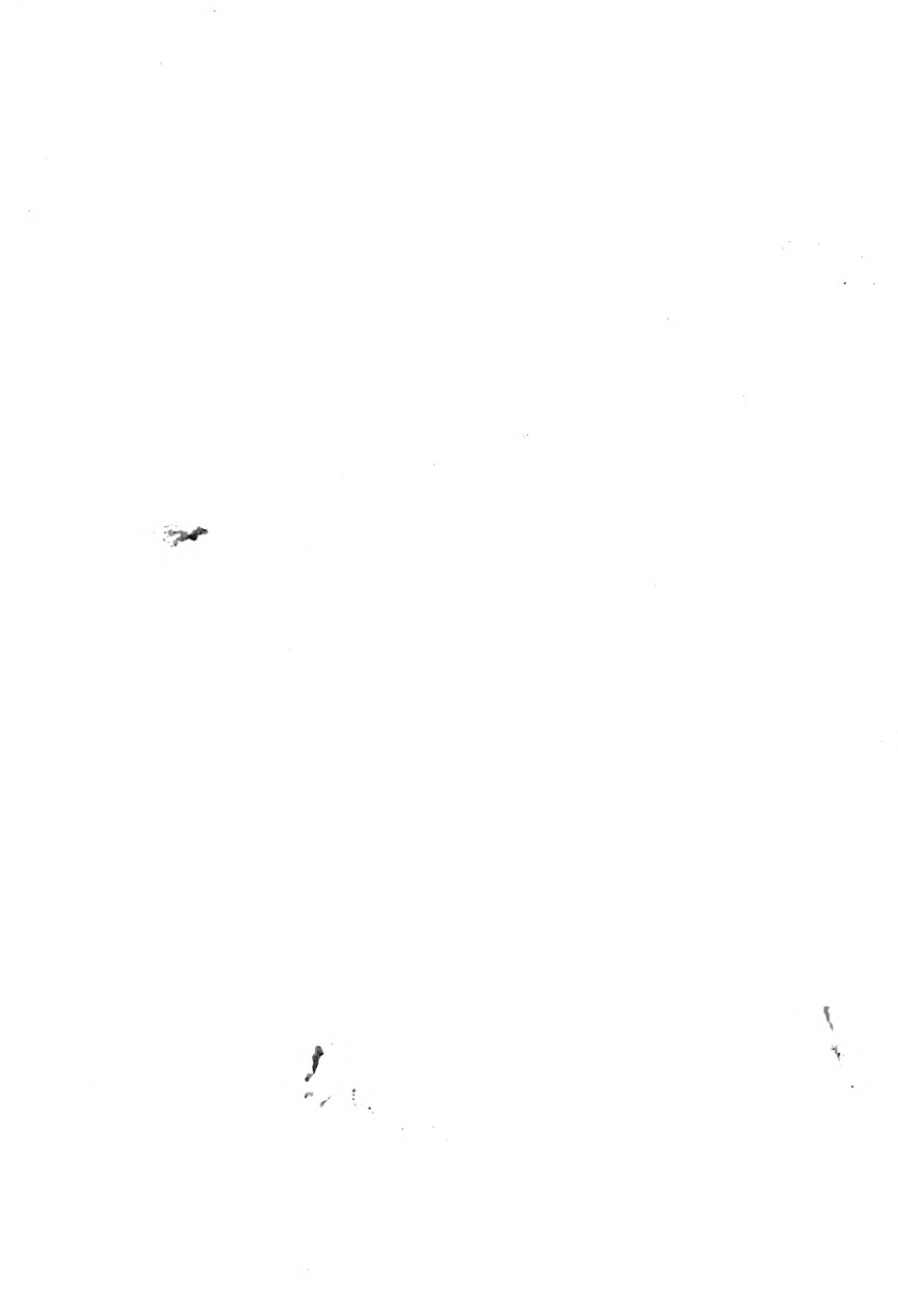


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*Under the Editorship of* **LEONARD CARMICHAEL**  
*Secretary, Smithsonian Institution; Formerly President,*  
*Tufts College, and Director, Tufts Research Laboratory*  
*of Sensory Psychology and Physiology*

INTRODUCTION TO



# *Psychology*

**NORMAN L. MUNN** · BOWDOIN COLLEGE

HOUGHTON MIFFLIN COMPANY · BOSTON

*Introduction to Psychology*  
is an abridged edition of  
*Psychology: The Fundamentals of Human Adjustment*,  
FOURTH EDITION

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PRINTED IN THE U.S.A.

*To my son Henry*

*I affectionately dedicate*

*this book*





## *Contents*

<b>1</b>	What Is Psychology?	3
<b>2</b>	The Scientific Study of Behavior	29
<b>3</b>	Individual Differences	51
<b>4</b>	Intelligence	79
<b>5</b>	Aptitudes	115
<b>6</b>	Motivation	137
<b>7</b>	Emotional Motivation	174
<b>8</b>	Frustration and Conflict	207
<b>9</b>	Personality	233
<b>10</b>	The Learning Process	270
<b>11</b>	Remembering and Forgetting	309
<b>12</b>	Thinking	337
<b>13</b>	Knowing Our World	365
<b>14</b>	Attending and Perceiving	391
<b>15</b>	Communication and Language	430
<b>16</b>	Social Behavior	456
 <b>APPENDIX</b>		
	Answers and Solutions	490
	Glossary	493
	Statistics	537
	References	543
 <b>INDEX OF NAMES</b>		
		573
 <b>INDEX OF SUBJECTS</b>		
		581



## Editor's Introduction

The present volume is an excellent and ingenious abridgment of the new fourth, or 1961, edition of the author's internationally famous *Psychology: The Fundamentals of Human Adjustment*.

Good and widely used university and college textbooks are one of the energizing and guiding forces in the development of any modern academic field. Dr. Munn's larger and very complete book in its various editions has done much to form the basic structure of thought about the nature of psychology for many members of the new generation of psychologists who have taken up the study of this subject during the last fifteen years.

Dr. Munn is an experienced and gifted college teacher. In his own class work, he has increasingly realized that for some courses his large *Psychology* is simply too long for use in a short course. The present smaller, but academically sound book necessarily omits topics treated in the more comprehensive volume, but it has been produced to meet a specific and important pedagogical need.

When an American psychologist considers the history of textbooks in his field, he inevitably thinks first of William James's great book, *The Principles of Psychology*, published in 1890. This work has 1,383 pages. There can be little doubt that part of the amazing and enduring influence of *The Principles* is due to the fact that James himself issued an abridgment of his monumental work in 1892. In his preface to this smaller volume of 478 pages, he begins with the sentence, "In preparing the following abridgment of my larger work, the *Principles of Psychology*, my chief aim has been to make it more directly available for class-room use." James's *Briefer Course*, as his condensed book came to be known, has had a lasting effect on American psychology and it also has contributed in no small way to the influence of James's thought on establishing the boundaries of what we today call scientific psychology.

The present editor feels that there is a parallel between James's great, and for its day comprehensive book, *The Principles of Psychology* and his *Briefer Course*, and Dr. Munn's influential, accurate and up-to-date large book, *Psychology: The Fundamentals of Human Adjustment* and his present briefer *Introduction to Psychology*. In his condensed volume, Dr. Munn has not in any unsound way attempted to prepare a popularization of scientific psychology. He has not watered down the ideas of modern experimentally based psychology. The new book is not, in an undignified way, "written down" to the student. The present *Introduction* rather is as up-to-date, as scholarly, as insightful and as clearly written as is the new fourth edition of Dr. Munn's large and famous textbook. The smaller book just does not cover as many topics, and the subjects it does cover are not all treated in as great detail as they are in the larger *Psychology*. The new *Introduction* is thus specifically intended for what William James well called a "briefer course."

Great textbooks, such as those that Dr. Munn has produced, are works of creative scholarship. As noted above, such books make a real contribution to the development of psychology as a science and as a profession. Dr. Munn, in the skill of his abridgment, has again made psychological history with the new *Introduction*. He has produced a volume that will help to introduce serious American university and college students, who cannot spare time to master his longer book, to some of the most important and most widely accepted facts and theories of modern scientific psychology.

In this briefer volume the student will learn that the scientific study of mental life can give him a new stability, a new energy and a new understanding of himself and of the social world of which he is a part.

LEONARD CARMICHAEL

## Preface

This abridgment of *Psychology* has the same basic aims as the larger book — to provide a survey of modern scientific psychology, to help students develop insight into the nature of psychological processes, and to suggest how psychological knowledge and procedures may be applied in the solution of personal and social problems. I have also been guided by the view that a study of psychology contributes to a well-rounded education.

The present book is designed especially for short courses. Most of the material is taken from the larger edition, but this is edited so as to delete certain physiological and experimental details for which there is insufficient time in a briefer course, as usually taught. Grouping of chapters into parts, with introductions to each part, has been omitted so as to provide greater flexibility for revision.

In order to make a completely meaningful abridgment it has also been necessary to add new material, including new illustrations and a new chapter. Many discussions have been revised and some topics to which two or more chapters were formerly devoted are reduced to a single chapter. More specifically, this *Introduction* compares with its predecessor in the following ways: Chapters 1 and 2 (What Is Psychology? and The Scientific Study of Behavior) are taken over unchanged. Chapters 3 and 4 (The Human Organism, Development in the Individual) are omitted, although some of the material has been incorporated elsewhere. Chapter 5 (Individual Differences) is retained without major changes. Chapters 6 and 7 (Nature and Testing of Intelligence, Differences in Intelligence) are modified to provide but one chapter on intelligence. Chapter 8 (Aptitudes) is used again. Chapters 9 and 10 (Personality — Nature and Assessment, Personality — Origins and Outcomes) are reduced to a single chapter on personality. Likewise, Chapters 11 and 12 (The Motives of Animals and Men, Personal-Social Motives) are replaced by a single chapter on motivation. Chapter 13 (Emotional Motivation) is modified by dropping some physiological details and taking account of the fact that there is now no earlier chapter on the nervous system. Chapter 14 (Frustration and Conflict) is unchanged. Chapters 15, 16, and 17 (The Conditioned Response, Acquiring Skills, and Foundations of Learning) are abridged and in part rewritten so as to form a single chapter on the learning process. Although some topics were omitted, this reduction was achieved primarily by removing neurological material. Chapters 18 and 19 (Remembering and Forgetting, Thinking) are basically unaltered. A new chapter (Knowing Our World) partially replaces Chapters 3 (The Human Organism), 20 (Vision), and 21 (Hearing and the Other Senses). In this new chapter our emphasis is on the encoding and decoding of sensory messages. It is a straightforward discussion of stimuli, how they impinge upon the receptors, and how informa-

tion is encoded in the nervous system and decoded by the cerebral cortex. Essential anatomical details are included but most of the sensory material of experimental psychology (color mixture, overtones, sensory adaptation, and the like) are omitted. In short, emphasis is on *how* we see, hear, taste, and so forth, rather than description of experience. Chapter 22 (Attending and Perceiving) is retained except for some neurological details. Chapter 23 and 24 (Communication and Language, Social Behavior) are included without major change. Chapter 25 (Working Efficiently) is omitted.

In these ways, the Fourth Edition of *Psychology* reduces to the present sixteen chapters. Although this *Introduction* has been designed to serve those who feel that the earlier book is too large and detailed, or that it includes too much physiological and sensory material, some will doubtless wish that the order of the chapters were different or that the author had retained certain topics now omitted. However, as arranged here, the course lends itself to almost any desired sequence and anybody who feels the need to reintroduce certain topics can of course do this in his lectures even though these are missing from the present textbook.

Modifications correlating with those described above have also been made in the references, glossary, appendix and accompanying manuals. The *Student's Manual* retains exercises that the student may do on his own to contribute to his understanding of the text and, like the earlier manual, it includes a wide variety of correlated self-testing exercises and lists of the important terms from each chapter.

This abridgment has of course benefited from the contributions of those who helped me in various ways with *Psychology* (Fourth Edition). Thus I wish to repeat the following acknowledgments: Dean E. Parker Johnson of Colby College drew several sketches from which some of the present illustrations have profited. The present treatment of statistics still owes much to the advice of Dr. A. B. Shaklee of the University of Denver and Dr. David L. Russell, my former colleague, now at Ohio University. Another colleague, Dr. Merle Moskowitz, who has since moved to the University of Pittsburgh, helped in many ways.

Illustrations have come from sources too numerous to acknowledge here in detail. Those from journals and photographic agencies are acknowledged where used. Most of the photographs without acknowledgment were taken by Mr. Stephen Merrill of Brunswick. The various drawings and graphs were done by John Awtrey, Elmer Smith, Frank Nicholas, Lilli Mautner, Austin Stevens, and the Hagstrom Company. I am greatly indebted, also, to Gale Parker and Amy S. Weadock of the publisher's Educational Art Department, for their diligence and good judgment in coordinating my desires with respect to illustrations and the work of the above-mentioned artists and illustrators. They also obtained many of the photographs.

Dr. Leonard Carmichael, in his capacity as editor of the Houghton Mifflin Psychology Series, subjected the manuscript to his usual detailed criticism, with a resulting improvement in its quality. I am also indebted to Richard N. Clark, the Houghton Mifflin editor responsible for translating the manuscript into a printed textbook. His sympathetic understanding of my educational aims and his ability to transfer these to the printed pages are very much appreciated.

## *To the Student*

Your experience and behavior have much in common with the experience and behavior of other people. Even your problems of adjustment — the frustrations to be overcome, the aspirations to be achieved, the emotions to be controlled, the personal and interpersonal conflicts to be resolved — are shared by many others. So look upon this as a book about yourself — not as a treatise on some hypothetical human being. While studying it, continually ask yourself, "How does this apply to me?" Remember, too, that the study of psychology can give you insight into the conduct of other people. It should increase your understanding of why they behave as they do and, through this understanding, improve your ability to predict, perhaps even control, their behavior. Applications of psychology in the home, in the classroom, in the professions, in business, in industry, in warfare, and in the perpetuation of peace are focused primarily on the prediction and control of human conduct.

Observe that each chapter has a summary which brings its contents to a sharper focus. You may find it profitable to read this summary first, then reread it after reading the chapter. This suggestion is in accordance with the principle that ideas are most readily conveyed to others when you tell them what you are going to tell them, tell them, then tell them what you have told them.

Students are often confused by a profusion of names and dates which serve to identify the author's sources. My policy has been to mention very few names in the body of the text, and then only the names of people who are historically important or especially identified with certain theories. Most of these names occur in the first chapter, which is an historical introduction to psychology. Following the custom in many present-day textbooks, quotations and passages dealing with particular researches to which I have referred are identified by a small number. If you wish to identify the person whose contribution is involved, turn to the proper part of the appendix, the page number of which is given at the end of each chapter just preceding the selected readings. On this page, or possibly its continuation, locate the reference number. There you will find the author, the source, and perhaps notes and other references. Do not try to memorize such information. These references and notes will be of use to you, however, if term papers or other reports are required. They will enable you to track down relevant information.

This course will add immeasurably to your vocabulary. All major psychological terms are defined in the glossary. If you find a term the meaning of which is not sufficiently clear from the definition in the text, or from its context, turn to the glossary for help.

Information on how to study, brief exercises and experiments that you can do yourself and which parallel each of the chapters of the textbook, as well as a large

number and variety of self-testing exercises are presented in a *Student's Manual* designed to accompany this book. The self-testing exercises should help you to determine, after reading each chapter, how well you have grasped its contents. Since the questions are designed like those you will need to answer on quizzes and examinations, their use should give you training in how to handle the tests which count toward your grade in the course. But you will find it most advantageous in the long run if you work on your own and answer each item of a self-testing series before looking at the answers, which are in the appendix of the *Manual*.

You will observe that each chapter of the textbook ends with a list of books and some notes about each. These books are relevant to one or more topics in the chapter. They are, of course, not listed with the idea that students will necessarily read them. Their inclusion is for the convenience of those who may wish to delve more deeply into a topic or to get reference material for term papers or other reports. The books listed are among the most recent in the respective areas. Most have appeared within the last decade.



INTRODUCTION TO

*Psychology*



# *What Is Psychology?*



The nature of science • The scope of psychology • The influence of evolutionary biology • The rise of child psychology • Concern for the individual  
• Systems of psychology • General psychology • Summary

There are many false notions about psychology and psychologists. One of these is the belief that psychologists can read your mind or estimate your character at a glance. Another misconception is that they are authorities on such things as spiritualism, mental telepathy and fortune-telling. Psychologists are, in fact, often called upon to explain how a currently famous “mind reader” does his tricks or how a certain astrologer could have predicted some historical event.

One often meets people who assert that they are themselves psychologists. Why? Because they are “observers of human nature” and can “sum up people” at a glance. One well-educated man known to the writer felt that he could tell whether or not a person is narrow-minded by noting the distance between his eyes. Some claim that they can discern dishonesty from shifty eyes, or from the inability of a person to look them steadily in the eyes. Such claims come from an honest misunderstanding of what psychology is and can do.

There are also many people without scientific training who make a dishonest living out of a gullible public by setting themselves up as self-appointed psychologists. These “psychoquacks” will study a person’s head, his facial characteristics, the date of his birth, or his handwriting and then, in accordance with their own particular theories, tell him what his capacities are, the sort of person he should marry, or how he should plan for his future.

Members of this "psychological underworld" have been known to offer courses in psychology by mail and to give a "doctor of psychology" degree for a price. There is, in fact, no legitimate doctor of psychology degree. Psychologists have degrees like other scientists, degrees granted by reputable universities.

Even apart from honest misconceptions and psychological racketeering, the terms "psychology" and "psychological" are often used in a very loose way. One hears people speaking about "the psychology of the French," "the psychology of the fraternity man," or "the psychology of the industrialist." One also hears of the "psychological moment" to close a deal, or to make a proposal. These terms are used with little or no regard for the actual nature of psychology.

Psychology is a science and the properly trained psychologist is a scientist, or at least a practitioner who uses scientific methods and information resulting from scientific investigation. But what is science?

### THE NATURE OF SCIENCE

Science begins with observation. The importance of such a start is suggested by the following story from Francis Bacon, a leader (1605) in the history of scientific investigation.<sup>1</sup> \*

In the year of our Lord 1432, there arose a grievous quarrel among the brethren over the number of teeth in the mouth of a horse. For 13 days the disputation raged without ceasing. All the ancient books and chronicles were fetched out, and wonderful and ponderous erudition, such as was never before heard of in this region, was made manifest. At the beginning of the 14th day, a youthful friar of goodly bearing asked his learned superiors for permission to add a word, and straightway, to the wonderment of the disputants, whose deep wisdom he sore vexed, he beseeched them to unbend in a manner coarse and unheard-of, and to look in the open mouth of a horse and find answer to their questionings. At this, their dignity being grievously hurt, they waxed exceedingly wroth; and, joining in a mighty uproar, they flew upon him and smote him hip and thigh, and cast him out forthwith. For, said they, surely Satan hath tempted this bold neophyte to declare unholy and unheard-of ways of finding truth contrary to all the teachings of the fathers. After many days more of grievous strife the dove of peace sat on the assembly, and they as one man, declaring the problem to be an

everlasting mystery because of a grievous dearth of historical and theological evidence thereof, so ordered the same writ down.

The youthful friar of this story was enunciating the fundamental principle of all science; namely, to seek the facts rather than depend upon authority or upon sheer speculation.

The scientist does not, however, collect all and sundry facts, even within the field of his major interest. Like the disputants of Bacon's story, he begins with questions. These are questions which, to him, deal with issues of importance. He then looks for relevant information. If appropriate data have not already been reported by other scientists, he may carry out his own observations. These may be focused upon objects or events which occur naturally, as in the case of a geologist examining rocks or a biologist studying the migration of birds. Wherever possible, however, a scientist observes under controlled conditions. He varies aspects of nature and records the results. Early physicists, for example, varied the frequency of vibrating strings and observed that, as more vibrations per second were produced, the pitch of the resulting sound became higher. They were then able to formulate a general law governing the relationship between frequency of vibration and pitch. Without experimental observation this would have been impossible.

In carrying out his observations, experimental or otherwise, the scientist is not trying to prove something. He is impartial. He seeks information and, if this upsets a pet theory,

\* These numbers designate references listed in the Appendix and grouped by chapters.

the theory must be discarded, or at least modified to correspond with the facts.

Findings are not accepted by scientists unless they can be verified. This means that others must be able to repeat the observations and obtain the same results. The law of vibrating strings mentioned earlier was not accepted until others repeated the experiment and observed the reported relationships.

Thus scientists look for information with which to answer significant questions. Where possible they experiment. This is because experimental information is most conducive to the discovery of lawful relations and because the results are verifiable. As scientific observation proceeds, many seemingly disparate phenomena are found to be interrelated. Increasingly comprehensive formulations are therefore developed. It is then possible to predict and even to produce events not previously observed. Such formulations made possible the first atomic explosion and the launching of an earth satellite. Scientific prediction occurs on a much less spectacular scale whenever a geneticist, mating animals with different characteristics, is able to say what the offspring will be like with respect to these characteristics. It is also evident when a psychologist is able to say that the illumination of a room must be increased by at least one per cent before it will be experienced as brighter or when he says that 95 per cent of a group of flight candidates with a particular score on a battery of special tests will learn to become pilots.

The rest of this chapter is designed to clear up misconceptions about the nature of psychology, to show how it became a science and to indicate, in an introductory way, the present scope of its investigations. The following chapter considers in more detail the application of scientific techniques to solution of psychological problems.

## THE SCOPE OF PSYCHOLOGY

Since psychological observations are focused upon living organisms, psychology is a biological science. It is, in fact, one of several biological sciences, each distinguished from others through its concern with some special aspect of living things. The distinguishing feature of psychology is that it observes and

attempts to understand the *behavior* of organisms. It is concerned primarily with their responses to the world around them.

Man is not only a biological organism but also a social one. His behavior is modified by and in turn modifies the behavior of others. Psychology is therefore a social as well as a biological science. It must take account of the fact that human babies are dependent upon others for survival and that, during this dependence, their ways of behaving, including their language, are imposed upon them, wholly or in part, by their elders. As a result, they come to act less like little animals and more like human beings. Psychology must also consider collective behavior as when human beings act in groups of various kinds.

Since the behavior of human beings is grounded both in biology and in social interaction, psychology is often referred to as a *biosocial science*. The appropriateness of this designation becomes increasingly apparent as psychologists penetrate the intricacies of human behavior.

## The beginnings

The word *psychology* was actually derived from two Greek words, *psyche* (soul) and *logos* (discourse). Psychology, or "mental philosophy," was thus literally a study of the soul. The term "soul" did not at first have religious implications such as it has today. For some it was an inner flame, for some a form of motion, and for others a function of bodily processes.

About 400 years ago mental philosophers began to translate *psyche* as "mind" and psychology was then defined as "a study of the mind." This definition continued in use until the present century. It was eventually replaced by the definition of psychology as "the science of behavior." How this happened will become apparent as we proceed to survey events which led to the rise of modern psychology.

## Scientific roots

The emergence of psychology as a science occurred less than a century ago. This event was stimulated by certain achievements of physicists and physiologists. Physicists discovered the relation between aspects of the environment



Wilhelm Wundt

The laboratory founded by Wundt in 1879 trained many of the early experimental psychologists, including several who established similar laboratories in this country.

(stimuli) and elementary experiences, or "sensations." Sound sensations, for example, were found to depend upon the frequency of sound waves. At the same time, physiologists were discovering the structure of the sense organs and brain which, when stimulated, give rise not only to sensations but also to various reflexes and other aspects of behavior. These successes, especially with respect to sensation, something very close to the interests of mental philosophers, suggested that psychology might itself become an experimental science.

Although it is difficult to say exactly when scientific psychology began, three German scientists are usually credited with having an important part in its birth.

One of these, a physiologist named E. H. Weber found that he could measure and thus quantify certain aspects of sensory experience.

His studies led to an important formulation known as Weber's Law. The general question to which he sought an answer can be stated quite simply. It was this: "How much must intensities of stimulation differ before one can notice the difference?" Take the lifting of small weights, for example. Suppose that you lift one weight, then a second weight. How much heavier (or lighter) must the second be before a difference is felt? After many experiments, sometimes with the second weight equal to, sometimes lighter than, and sometimes heavier than the first weight, Weber was able to formulate his law. He had discovered that a just noticeable difference in weight is a constant fraction of the first of the pair of weights compared, i.e., that which serves as the standard in a series of judgments. In the case of lifted weights, this fraction was  $1/30$ . Thus, if one lifts 30 ounces and then 31, the second feels heavier. But if the second weight is only 30.5, one cannot observe this difference and both feel equally heavy. Suppose, however, that the standard weight is 90 ounces? How much heavier must the second be if one is to feel it as heavier? The answer is 93, or, again,  $1/30$ th of the standard. This fundamental principle holds, with some limitations, in vision and in other senses, although with the particular fraction depending upon the sense involved. With respect to illumination, for instance, a just noticeable increase in brightness requires  $1/100$ th of the illumination with which one begins.

The second scientist to play an important role in early scientific psychology was a physicist named Fechner, who not only extended Weber's procedures for measuring the relation between external stimuli and sensory experience but also developed a more precise formulation of experimental findings. In 1860 Fechner published the results of his work in a highly influential book entitled *Elements of Psychophysics*.

The third of our scientists was a physiologist and philosopher who, because he founded a laboratory of psychology, is considered by many to be the "father of scientific psychology." This was Wilhelm Wundt.

#### The opening of Wundt's laboratory

The formal founding of psychology as an

experimental science occurred in 1879 when Wundt opened his psychological laboratory at the University of Leipzig. He had seen the fruitfulness of experimental methods in physics and in physiology, where many of the problems dealt either with stimuli basic to human experience or with the underlying biological structures and functions. What impressed him especially was Weber's and Fechner's success in formulating lawful relations between intensities of stimulation and the corresponding experiences. Such findings seemed to refute the widely held view that mind could not be measured and hence that psychology could never become a science. Now it seemed apparent that mind, or conscious experience, regarded by Wundt as synonymous with it, could indeed be measured.

### The nature of Wundtian psychology

Wundt at first adopted relevant apparatus which physicists and physiologists had been using. Very soon, however, investigators in his laboratory were discovering new problems and devising apparatus and procedures of their own. The aim of the new science, as Wundt envisaged it, was to analyze conscious experience much as the chemist analyzes matter into its elements. Apparatus played a part in this because it was needed to manipulate and measure the stimuli used to arouse experiences. The really distinctive feature of Wundt's procedure, however, was its utilization of what was called *experimental introspection*. Introspection itself was of course not new. Anybody who, so to speak, turns his thoughts inward and examines or reflects upon his experiences is introspecting. But those who made observations in Wundt's laboratory were specially trained and they attempted to analyze experience *in process* rather than reflecting upon it after it had occurred. What they were after was the nature of *immediate* experience and, among other things, their training was designed to facilitate such observation. Wundt referred to the new science first as "physiological psychology" and later as "experimental psychology."

The major emphasis in Wundt's laboratory was on sensations and more comprehensive sensory experiences called *perceptions*. However, there were also attempts to measure emo-

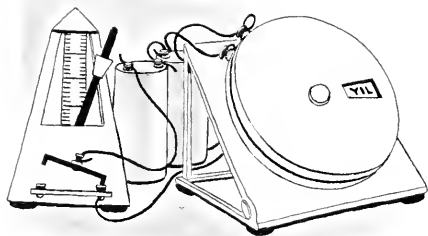
tional feelings as well as images and ideas. Observations were later extended to experiences involved in motor reactions to stimuli. Conscious aspects of thinking were also studied. But Wundt was not content merely to analyze and describe conscious experience. He also wanted to know the underlying biological structures and functions.

Because of its preoccupation with the conscious aspects of human life, psychology was at this time defined as "the science of conscious experience" and anything which did not lend itself to investigation through experimental introspection was thought to be outside its sphere of interest. Nevertheless, the infant science soon outgrew such limitations.

Even within the general area which Wundt first mapped out for scientific investigation there was a broadening of scope. Attention gradually shifted from descriptions of conscious experience to investigations focused upon the use of sensory and perceptual processes in the initiation and control of behavior. Indeed, work in this area still goes on. Scientists in various fields, and especially physiology and neurology, share the psychologist's interest in such processes. Moreover, the findings in this and related areas of psychology have had great practical significance in industry and the armed services, where the design of equipment which men are called upon to operate must take into account their sensory and other capabilities.

### New areas of investigation

While Wundt and his associates studied conscious experience, others were opening up new fields of investigation. A German philosopher named Herman Ebbinghaus began the experimental psychology of memory. He attempted to answer such questions as: How do we remember? What makes us forget? What are the most efficient procedures for memorizing? Such questions had always engaged the attention of mental philosophers. Now, instead of merely talking about them, or depending upon what some authority like Aristotle had said, Ebbinghaus tried to answer them experimentally. He memorized verses of poetry and meaningless groupings of letters called *nonsense syllables* (Figure 1.1) and he did so under conditions designed to answer



**1.1 A Memory Apparatus.** This early apparatus (Rorschach's) exposed one nonsense syllable at a time. The rate of exposure was controlled electrically with a specially constructed metronome.

his questions. One can see here an interesting shift in emphasis. Instead of describing conscious experience, as Wundt had done, Ebbinghaus was concerned with how well the learner could repeat what he had memorized. This was an emphasis upon behavior; more specifically, language behavior.

The results of these investigations on memory were published in 1888. Some of Ebbinghaus' questions were answered. Some results raised additional questions and various extensions and modifications of the methods developed by Ebbinghaus were soon being used to answer these. In fact, this is another area of psychology in which research continues, and with outcomes of practical as well as scientific significance. Findings on memory are of obvious value in education and they comprise an important aspect of the area now known as *educational psychology*.

**Learning.** Research on memory was important in opening up the whole field of learning to experimental investigation. When we memorize, we are usually learning verbal material such as words, numbers, or other symbols. Thus research on memory is largely concerned with what has been called *verbal learning*. Very soon after Ebbinghaus' pioneer research in this more restricted area of learning there developed an interest in so-called *motor learning* where, although verbal aspects

may be present, emphasis is on overt acts like hitting a target or, at a more complicated level, typing or playing a musical instrument. As in the case of research on memory, pertinent questions which investigators attempted to answer had to do with how learning occurs and how one may increase its efficiency. The outcomes of such research, which is more vigorously pressed today than ever before, are of obvious value in education and in various other fields of everyday life. Industrial psychologists, for example, often have as their major responsibility the efficient training of workers in the specific skills which modern industry requires.

**Individual differences.** Another area of investigation, the results of which were to have scientific as well as practical value, both in education and elsewhere, was that dealing with individual differences. Weber, Fechner, Wundt, Ebbinghaus and their fellow investigators were concerned with the study of *processes* (sensation, perception, memory, learning) and in discovering general principles pertaining to these. They paid little or no attention to the fact that there are individual differences in sensitivity, in memory, and in learning ability.

Individual differences had not completely escaped observation. The early Greeks discussed such differences and Plato made much of them in his *Republic*. They had also been noted in astronomy. Many years before Wundt's laboratory was opened, a noted astronomer had discharged his assistant for perceiving the transit of stars across the hair of the telescope nearly a second later than he himself perceived it. Another famous astronomer, seeing a reference to this earlier incident, decided to compare his own reports on such transits with those of fellow astronomers. There were marked differences, even among these experts. Such a difference came to be called the *personal equation*.

Although individual differences had been observed and discussed by philosophers, astronomers, and others, little of scientific importance had come of it. While Wundt was starting his laboratory at Leipzig, however, an Englishman named Francis Galton began to measure individual differences in bodily measurements and, more or less incidentally, in such psychological functions as sensitivity and



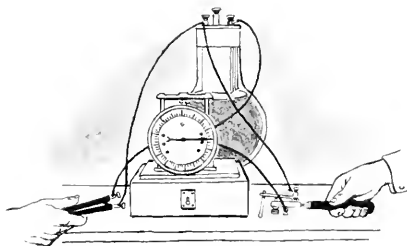
imagery. His primary purpose was to trace the hereditary origins of such differences.

These earlier observations of individual differences, and especially Galton's, inspired J. McKeen Cattell, an American student in Wundt's laboratory, to undertake an extensive study of individual differences as such. The differences studied were in such things as vision, hearing, memory, and speed of reaction (Figure 1.2). The instruments and materials used to measure such differences came to be called mental tests. These were not intelligence tests in the modern sense, but they foreshadowed present-day tests and especially the aptitude tests now so widely used to select persons for various occupations.

One outcome of these studies was the development of statistical methods for analysis of individual differences. Statistical analysis not only revealed norms (such as averages) but also the extent to which individuals differ (variability) and relationships (correlations) between differences in one area (say body build) and in another (such as personality).

Intelligence tests of the kind in use today were devised and first put to practical use early in this century. The pioneer intelligence tester was a French psychologist named Alfred Binet, who used his tests to decide whether or not a child had sufficient mental development to profit from normal schooling.

*Observers and subjects.* We have seen that scientific psychology began by studying aspects of conscious experience and that, as new investigators entered the field, its scope was broadened to take in memory, the learning process, and also individual differences. In the course of these developments there was a gradual shift of emphasis from descriptions of conscious experience to observations of behavior. Those who studied memory and other aspects of learning were concerned more with *what was done* than with associated experiences. Even the name given to those who served in psychological experiments indicates this shift. Wundt and his followers called the person who introspected an *observer*, the reason being that he observed his own experiences and reported them to the investigator. Later psychologists, and especially those who were not so much concerned with conscious experience, were themselves the observers. They observed behavior. Those who



**1.2 An Early Form of Chronoscope for Measuring Reaction Time.** This is the D'Arsonval chronoscope. The subject was seated with the response key in his hand. When the experimenter struck the top of the table (or the subject's hand) with his key, he gave the signal for response and simultaneously opened an electrical circuit which caused the chronoscope pointer to engage with a clockwork device. It then swept the dial once per second. As soon as the subject squeezed his key, a circuit connected with a magnet was closed, thus disengaging pointer and clockwork. Since the experimenter's signal activated the pointer and the subject's signal stopped it, the elapsed time, read in 1/100 sec. units, gave the latter's speed of reaction. (After Binet.)

memorized, learned the skills being studied, and took mental tests were then referred to as *subjects*. Today the term *subject* is in almost universal use to represent an organism, human or animal, studied by the psychologist.

## THE INFLUENCE OF EVOLUTIONARY BIOLOGY

The idea that man is the end product of developments initiated in lower organisms and that his structures as well as his behavior are foreshadowed in the structures and behavior of prehuman animals is ancient. It appears in Greek philosophy. Several philosophers of the eighteenth and early nineteenth centuries also held this view. Thus the concept of evolution, although popularly attributed to Darwin, did not in all respects originate with him.

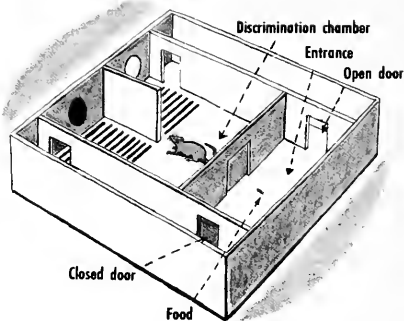
## Darwin's contributions

Prevailing opinion in Darwin's day was that each species had an independent creation. The idea that one might have changed gradually into another was talked about, but there was apparently insufficient supporting evidence. In reality, there were many facts which, if their significance had been realized, would have made a strong case for evolution. Some of these had been known for a long time. Others were observed by Darwin himself. Darwin's major contribution, however, was to synthesize these facts; to show their relation one to another. The result was a factual basis for evolution. Darwin then formulated a theory designed to explain evolution. This is the theory of natural selection. It calls attention to wide variations in the structures and reactions of a given species. It makes a point of the struggle for existence, a struggle which leads to the survival of relatively few. It argues that survivors in this struggle are the fittest, those with variations which adapt them most adequately to their environment. The poorly adapted perish and have no offspring. Survivors pass their desirable characteristics to offspring through heredity. The theory supposed, moreover, that this process, carried on over millions of years, led to the appearance of such distinctly different organisms as, for example, cats, monkeys, apes, and men.

Darwin's theory of the survival of the fittest through natural selection proved highly controversial. The argument as to *how* evolution occurred still goes on. Nevertheless, as we shall observe shortly, Darwin's views played an important part in the development of psychology as a science of behavior.

By demonstrating the factual basis of evolution and by suggesting how organisms may have evolved, Darwin took the evolutionary concept out of the sphere of pure speculation and placed it in the area of natural science. Indeed, the publication in 1859 of his *Origin of Species* was a major step in the history of scientific biology.

In the course of his research, Darwin made some historically important observations on emotion. These were brought together in his *Expressions of Emotion in Man and Animal*, published in 1873. Darwin's main thesis, supported by an accumulation of evidence, is



**1.3 An Early Form of Discrimination Apparatus.** When a hungry animal enters the discrimination chamber, it is confronted by two stimulus patterns (in this case, a white and a black circle). In front of each pattern is an electric grid. Suppose that the investigator decided to reward response to white and to punish response to black. Now, if the animal goes to the white area, it proceeds along the side alley and back to the entrance where a small food pellet has been placed. If the animal goes toward the black, on the other hand, it receives a shock through the floor. Moreover, if it continues, it does not have access to the food. This means that it has to come back and correct its response. On the next trial, the white area may be on the left. It is alternated from right to left in accordance with a chance sequence. This problem must be solved visually and not by going in a particular direction.

that many human emotional reactions are meaningless except when viewed as useless carry-overs from our animal ancestors. During intense rage, for example, men tend to bare their canine teeth. This is for them a useless reaction. Then why do they do it? Darwin pointed out that when this occurs in animals, it serves to frighten the object of rage and also to bare the teeth for action. Although the reaction is useless to us, we inherit it, much as we do our useless appendix.

## The study of animal behavior

By pointing out that man's psychological as

well as structural characteristics evolved from those of prehuman organisms, Darwin brought psychological attention to animal behavior. Psychologists as well as biologists began to investigate so-called "instincts." These are complex unlearned behavior patterns. Examples are: a spider spinning its web in a certain pattern characteristic of the species, a wasp paralyzing a caterpillar and depositing its eggs on the animal, or a bird building a nest which typifies its species. The question then arose as to whether man himself has instincts. This is still a controversial issue and we will discuss it later in this book.

Out of an interest in animal behavior came studies of sensory processes and learning ability in animals. These began with such questions as: At what level of evolution does consciousness appear? How do the conscious experiences of animals compare with those of man? Do animals have anything resembling human intelligence? Are they capable of reasoning?

The first attempts to answer such questions used a procedure referred to today as *anecdotal*. Naturalists gathered stories about the behavior of animals, usually pets of the informants, and arranged these systematically in such a way as to demonstrate the evolution of intelligence. Such stories are, of course, unreliable. The owner of a pet, like the parent of a child, is not the best judge of its intelligence. Moreover, human beings have a tendency to anthropomorphize, to humanize, or see human traits in animals. This is well illustrated in an ancient Chinese story.

Chuang Tzu and Hui Tzu were standing on a bridge across the Hao River when Chuang said, "Look how the minnows are shooting to and fro! How joyful they are!"

"You are not a fish," said Hui. "How can you know that the fishes are joyful?"

"You are not I," answered Chuang. "How can you know I do not know about the joy of the fishes? . . . I know from my own joy of the water."

Still another difficulty with anecdotes is that the unscientific observer, in his effort to tell a good story, often exaggerates. Science cannot rely on such evidence. Its observations must be systematic, they must be impartial, and they must be verifiable. For these reasons, anecdotes

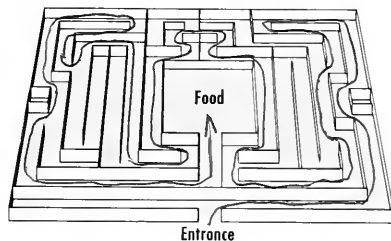
were soon replaced by experimental investigations designed to answer specific questions about animal intelligence.

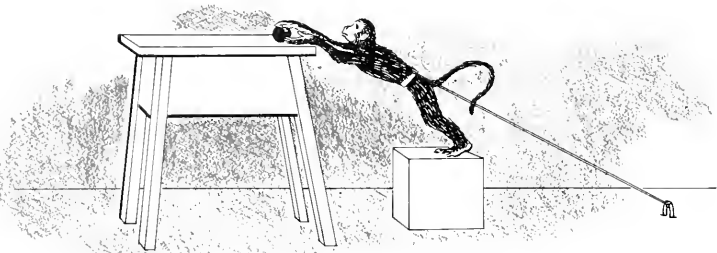
Does this animal sense the various aspects of its environment, like colors and sounds? Methods of answering such questions involved a discrimination technique, a simple form of which is shown in Figure 1.3. How does this animal's intelligence compare with that of another? This question was answered by using tests of learning ability like those shown in Figures 1.4 and 1.5. Here the comparison was in terms of how many trials an animal requires to learn and how many errors it makes.

### The problem of consciousness

The question of how to get inside the animal, so to speak, and study his conscious experience has never been solved. We can tell whether or not an animal responds to aspects of its environment like colors and sounds. We do this by studying its discriminative behavior. But we cannot answer such questions as what animal consciousness is like, nor even whether it exists. Therefore the question as to where consciousness first appears in evolution cannot be answered.

**1.4 An Animal Maze.** This was the first maze used to study learning in white rats. A hungry rat placed in the entrance received food when the center was reached. In successive runs an animal tended to reach the center more quickly and with fewer entrances into blind alleys. Finally the path was run without error from entrance to center. This maze, the prototype of many others, was used by Small at Clark University in 1900.





**1.5 Monkey Solving a Problem.** In order to reach food on the table, the monkey had to push the box into an appropriate position, mount it, and stretch, as illustrated. Apparently, the animal "judged, from memory or otherwise, that a certain arrangement would help him and set about making that arrangement." (After Hobhouse.)

Because of their preoccupation with conscious experience, Wundt and his students were naturally interested in the consciousness of animals. One of the latter was Titchener,<sup>2</sup> who in 1903 indicated the nature of this problem by saying:

Only by looking inward can we gain a knowledge of mental processes; only by looking inward under standard conditions can we make our knowledge scientific. Even when we are examining a mind as if it were an object in the outside world — when we are trying to understand the mental processes of a child or a dog or an insect as shown by conduct and action, the outward signs of mental processes — we must always fall back upon experimental introspection. For our own mind is our only means of interpreting the mind of another organism; we cannot imagine processes in another mind that we do not find in our own.

In a nutshell, anybody who undertakes to describe animal consciousness is inferring it from the animal's behavior and, whenever he does so, he is inevitably anthropomorphizing, that is, ascribing human characteristics to the animal he observes.

Inability to discover anything about the consciousness of animals handicapped another group of psychologists who called themselves

"functionalists." Whereas Wundt and his followers had been trying to *describe* conscious experience, and of necessity only at the human level, these psychologists thought that it should be studied from the standpoint of how it helps in adjustment. They argued that when consciousness evolved, it perhaps had survival value in the struggle for existence. In learning a motor skill, they said, we are at first clearly conscious of our activities. Then, as the habit approaches perfection, consciousness recedes. Eventually we may perform the habit without any conscious attention to what we are doing.

However, the functionalist position was weakened by the difficulty of studying conscious experience while one has his attention on what he is trying to learn and by the impossibility, as indicated above, of knowing if and when consciousness enters animal life.

Later functionalists, as we shall see, paid less attention to conscious experience and came to focus on the environmental and organic conditions associated with efficient learning. Their work on the learning process, both in animals and human beings, laid a foundation for other important developments in psychology. Like the work of Ebbinghaus on memory and of Cattell on individual differences, the study of learning processes in animals and human beings came to have great practical significance, especially in education.

## Animals as tools

Although evolutionary biology turned the attention of psychologists to animals and lessened their preoccupation with analysis of conscious experience, not all of their efforts, even with animals, had evolutionary implications. It became evident quite early that the structures of other mammals are similar to our own in basic details and that such subjects can be valuable tools in investigating certain aspects of behavior.

White rats and other animals have been used to study the relation between brain processes and behavior. We can operate on their brains, either before or after they have learned particular habits. Their brains can also be stimulated electrically, or with drugs, to discover the regions most intimately involved in control of particular responses. Experiments of this nature are impossible with human beings. Indeed, before animals came to play such an important role in physiological psychology our information about the relation between brain processes and behavior had to come from post mortem operations, from observing the behavior of people with accidental brain injuries, or from studying those who had undergone brain surgery to relieve pathological conditions. Research on animals, supplemented by whatever human data are available, has shown that certain regions of the brain have the same or similar functions in both animals and men. These studies have also revealed differences between human and animal brains, and between animal brains at different levels of evolution. Such differences are reflected in learning ability.

Animals have also been used to study the influence of glandular secretions on sexual and other aspects of behavior. These studies, like the neurological investigations already mentioned, are directly relevant to our understanding of human behavior. They are perhaps even more relevant than the neurological, since the glandular secretions of animals serve the same basic functions in them as in us, and are good substitutes for our own secretions when these are lacking or insufficient; in the case of diabetics, for example, patients are injected with insulin from the pancreatic glands of animals, or with synthetic insulin having the same chemical structure as the secretions of these glands.

Research with animals has given us a great deal of insight concerning the evolution of intelligence, the nature of the learning process, and the psychological significance of our own physiological structures. But it has done more than this. Such research has suggested more fruitful ways of studying human behavior and opened up avenues of information once thought to be available only through introspection. We will see later that modern theories of learning have grown out of work with animals and that their hypotheses are frequently tested through experiments on animals. Here the relative simplicity of animals is helpful rather than otherwise. This is because it is usually more fruitful to begin with simpler organisms than to begin with those that are infinitely complex, like human beings. A medical student begins by studying and operating on simpler creatures like dogfish and cats. The builder of skyscrapers begins with simpler projects. Similarly, the investigator of learning begins with the simplest forms of learning, and these are found in lower animals. With them the investigator cuts below the ideals, purposes, attitudes, and culturally conditioned complexities of human behavior in order to learn what he can about the foundations which we share with other organisms. He feels that he will then be in a better position to understand the added complexities of human behavior.

## THE RISE OF CHILD PSYCHOLOGY

It is a curious thing that the scientific study of child behavior is only of recent origin. Philosophers had talked about the importance of childhood in determining the nature of the adult and poets had written about it.

The childhood shows the man,  
As morning shows the day.

Milton in *Paradise Regained*

The child is father of the man.

Wordsworth, *My Heart Leaps Up*

Two parents, including Charles Darwin (1877) published infant biographies. But the first comprehensive study of child development did not appear until 1882. This was Preyer's *The Mind of the Child*. It, also, was written by

a father and observation was limited to one child. Although restricted in these ways, this was a careful study dealing, for example, with reflexes, sensory ability, emotional development, and thought processes. It is, in fact, a landmark in the history of child psychology.

Like anecdotes in animal psychology, child biographies soon gave way to systematic observations. Experimental methods came to have an important place in such studies and these methods were often similar to those already found so fruitful in the investigation of animal behavior. This is not surprising when we consider that infants, like animals, are incapable of providing introspective data. Even from children old enough to speak, introspective information is, to say the least, of very limited value.

### Evolutionary influences

One idea which played an important part in evolutionary biology also gave an impetus to child psychology. This was the concept of *recapitulation*, which supposed that, in their early growth, organisms exhibit, for a time, certain traits possessed by animals lower in the evolutionary scale. Some structural evidence for this came from the fact that human fetuses have structures resembling gill slits. These later become a part of the ear. Likewise, each human being has a tail which, except in rare instances, disappears before birth.

Impressed by evidences for structural recapitulation, some early child psychologists looked for behavioral evidence. It was suggested, for example, that "the child after birth recapitulates and uses for a time various phases of its prehuman ancestral behavior." Offered in evidence were the monkey-like antics of children and the tendency of many to walk on all fours. One of the early leaders in child psychology, G. Stanley Hall of Clark University, even claimed that the *cultural* history of man's behavior is mirrored in the activities of children, and especially in play. He believed that "The best index and guide to the stated activities of adults in past ages is found in the instinctive, untaught, and non-imitative plays of children." But the recapitulation concept, although it served for a time to focus psychological attention on children, received little support from observations of child behavior.

### Developmental schedules

When child psychology got under way there soon developed an interest in such questions as: What reactions are usual, or normal, or to be expected at given age levels? Research designed to answer such questions is often referred to as *normative*, a search for norms. Intelligence tests such as those which originated in France (p. 84) were normative but confined largely to memory and reasoning. They were, of course, designed for school children. They did not tell how a baby of three or six months, or of two or four years should be reacting. Nor did they deal, in any direct way, with sensory, perceptual and motor development.

The first extensive developmental schedules designed to tell parents what children usually do at various age levels from birth up grew out of research conducted by Arnold Gesell (Figure 1.6) and his associates at Yale University. Various test situations, involving response to such objects as dangling rings, cubes, and mirrors were used at the early age levels. At later ages the tests involved observations of language and social behavior. Large numbers of children were tested. Movies of their reactions were made and analyzed frame by frame to discover age changes in behavior. The chief outcome of this research was a detailed catalogue of the responses to be expected at successive age levels. Over and beyond its scientific value, information like this is of obvious value to pediatricians, educators, and parents.

### The influence of psychoanalysis

Like the poets quoted above, Sigmund Freud (1856-1939) and later psychoanalysts claimed that childhood experiences leave an indelible impression on adult personality. Freud emphasized experiences associated with sexual development. Others stressed the importance of frustration and insecurity in childhood, with or without sexual overtones. Regardless of such differences among them, these men helped to turn the spotlight on childhood and, more specifically on parent-child relationships and other aspects of family life. This approach supplemented and, as it were, rounded out the approaches to child psychol-

**1.6 Dr. Arnold Gesell Testing a Baby.** The dome was devised for one-way vision so that observers could see the baby without being seen themselves. (Edmund B. Gerard.)



ogy that we have already considered. Moreover, the influence of childhood on adult personality became an interdisciplinary problem, bringing about cooperative studies among psychologists, sociologists, and anthropologists. The latter were led to investigate how methods of child rearing characteristic of different cultures (such as Samoan, Hopi Indian, and Eskimo) influence the personality of adults.

### CONCERN FOR THE INDIVIDUAL

Psychology, as we have considered it so far, was especially concerned with what might be called purely scientific or theoretical issues. This was true despite the fact that many outcomes were later applied in education and in everyday life. Some psychologists even argued that psychology should remain in the "ivory tower." They felt it to be a science and not a technology. These men emphasized the study of such processes as vision, perception, learning, memory, and thinking. Their aim was to discover the psychological characteristics of men, animal species, or children. Even those interested in individual differences concentrated on aspects that were more or less abstract, like the range of differences, general tendencies, relations between differences in one trait and those in another, and the hereditary bases of differences.

Individuals, as such, are unique and science is customarily concerned with trends or general principles. Nevertheless, because they dealt with human beings, psychologists were soon involved in problems of individual adjustment. They then impinged on the educational sphere more than ever. And they also became involved in a province which had traditionally been a medical one. The eventual outcome was *clinical psychology*, involving the study and correction of behavior problems.

### Normal and abnormal people

When attention turned to individuals from the standpoint of helping them solve their problems the question arose as to the meaning of normal and abnormal. Where to draw the line between normality and abnormality is still controversial and it will be discussed in the chapter on personality. However, some people deviate so far from the customary that there is no question about their abnormality. These are the psychotic, the neurotic, the feeble-minded, and those who experience exceptional trouble in adjusting to educational and other aspects of their environment.

*The psychotic.* Psychoses are serious mental illnesses. Those suffering from such illnesses are known today as psychotic or, to use a medico-legal term, "insane." Psychotics were once thought to be "possessed of the devil"

and were thrown into dungeons and mistreated in various ways to "drive the devil out of them." During the last century and a half, however, the attitude toward such people has undergone a marked change. They are now regarded as mentally ill instead of "possessed" and what were once "asylums" have become mental hospitals. At first there was only custodial care in such hospitals. Today there is treatment designed to cure the patient so that he can again take his place in society.

But this is not the place to trace historically the development of humane treatment for the psychotic. Any history of psychiatry or of medical psychology tells the story and it has been summarized very interestingly and in detail in recent textbooks of abnormal psychology.

The scientific study of psychoses came about as a result of the changed attitude toward these disorders. As soon as the idea of demonic possession was given up, and psychotics were regarded as ill, medical men began to observe psychotic behavior, to classify its varieties, and to seek the real causes. They found that some such disorders result from destruction of brain tissue associated, for example, with untreated syphilis and with the ravages of old age. Such disorders are now classified as *organic psychoses*. Certain other psychoses appeared to have no such organic basis, but to result from deranged habits of thought. Because they were due to abnormal functioning in what was apparently a normal brain, these were called *functional psychoses*.

The study and treatment of psychotics developed as an aspect of medicine. But psychology, being a science of behavior, is concerned with both the normal and abnormal. In fact, the breakdown of a mechanism often tells us a great deal about its nature. If one discovers the causes of breakdown, moreover, he may be able to repair the damage, or even to prevent it. Prevention of behavior disorders is, in fact, the chief function of a field of psychology now known as *mental hygiene*.

### The neurotic

Behavior disorders classified as neurotic (sometimes as *psycho-neurotic*) are milder and also much more frequent than psychoses. It is seldom necessary to institutionalize neurotic

people. Moreover, their disorders are, so far as we know, all functional.

There are different kinds of neuroses and we have all seen one or more examples in people around us. Neurotics having a functional disorder referred to, in general, as *hysteria* may suddenly become blind or deaf, lose feeling in their limbs, become paralyzed, or forget who they are. Today, as we will see in Chapter 9, there are more specific names for hysterical disorders. Other kinds of neurotic behavior include unreasonable anxiety, compulsions to commit certain acts, and preoccupation with bodily aches and pains. These are also considered later. Hysteria has had such historical significance, however, that we now confine our attention to it.

One reason for calling hysteria a functional disorder is that its symptoms can be produced during hypnosis. The hypnotist merely tells his subject that he is paralyzed, for example, and the suggested symptom is thereby produced. Another reason is that such symptoms as the above may disappear during hypnosis. The hysterically blind see, the hysterically anesthetic feel again, and the paralyzed limb moves as suggested.

Although it had been practiced for centuries, hypnosis first came to scientific attention when something akin to it was used by Mesmer in 1766 to remove neurotic symptoms. Mesmer applied magnets to his patients and their symptoms forthwith disappeared. He discovered later that magnets were not necessary; that passes made with his hands, along with suitable suggestions, were sufficient. His method, known as "Mesmerism," soon came into ill repute. There were various reasons for this, one being Mesmer's claim that a sort of "animal magnetism" passed from him to his patients.

In true hypnosis the patient is put into a sleep-like trance. This procedure was, in fact, first called "neurohypnology" meaning nervous sleep. About a century ago, when medical men were using hypnosis to produce anesthesia many patients underwent painless surgery (even amputation of a limb) while hypnotized. But after anesthetics were discovered, hypnosis was seldom used.

The use of hypnosis in studying hysterical behavior was revived late in the last century by a French neurologist named Charcot, who believed that hysterics could alone be hypno-





**1.7 Jean-Marie Charcot.** In this lithoprint Chorcot (1825–1893) is shown demonstrating hypnosis before a class of doctors and medical students. (The Bettmann Archive.)

tized. Others did not share his view. They reached the conclusion that any person can be hypnotized provided he gives his consent and follows closely the instructions of the hypnotist. The latter view eventually prevailed. It appears that Charcot's subjects were selected and hypnotized by his medical assistants and that, in order to guarantee a good demonstration (Figure 1.7), they provided him with known hysterics.\* Of chief importance in this connection, however, is the fact that two men who were to become leaders in the study of neurotic behavior came under Charcot's influence. One of these was Janet, who introduced the concept of personality integration. He pointed out that neurotics tend, as it were, to be divided within themselves, whereas normal people represent an internal unity; that is to say, are *integrated*. The other man who came under Charcot's influence at this time was a young Viennese neurologist named Freud. Because of what he had witnessed in Charcot's classes, Freud was induced

to use hypnosis in the treatment of neurotic people.

Freud's hypnotized patients often recalled events, desires, and fears which went unrecognized in their waking life. They were not aware of these prior to being hypnotized and they did not remember them when brought out of the trance. Nevertheless, these unconscious residues of earlier experiences were believed by Freud to account for neurotic behavior.

The idea that behavior is influenced by events of which we are not conscious was revolutionary. Wundt had claimed that psychology is the science of conscious experience. Now Freud was saying that there is an unconscious realm which introspection cannot reach and which, nevertheless, plays an important role in human life. In addition to this revolutionary idea Freud introduced a new type of psychotherapy to be called "psychoanalysis." This made no use of hypnosis. Hypnosis was dropped for several reasons, the most important of which had to do with the fact that a person does not usually remember anything that happens while he is hypnotized. During the trance he may recall disturbing

\* See, in this connection, the recent biography of Charcot by Georges Guillain. The English translation, by Pierce Bailey, is *J.-M. Charcot*, Hoeber, 1959.



Sigmund Freud

Although he is best known as the founder of psychoanalysis, Freud began his academic career as a neurologist.

past experiences and even have an emotional upheaval while doing so. Recall of disturbing experiences and release of "pent up emotion" offers some relief to the patient. But Freud felt that it would be much better if his patient could recall and give vent to emotion while fully aware of what he was doing. Under these conditions he would be more likely to remember what had happened and thus receive greater benefit from it. Therefore Freud adopted his *free-association* technique in which patients said everything which came to mind while relaxing on a couch. They also talked about their dreams and used these as points of departure for free association. During many sessions, sometimes over a period of years, the patient's "unconscious" was, so to speak, emptied out. The outcomes of this procedure were studied and evaluated as a basis for under-

standing the patient's problems and suggesting ways of adjusting to them.

While using his approach to neuroses, Freud very soon reached the conclusion that these disorders result from frustrated sexual desire, or from anxieties associated with sexual functions. He pointed out that we are taught from early childhood not to talk about, or even think of sex. Failure to observe these teachings is followed by shame. Because we are taught that sex is shameful, we repress experiences and thoughts associated with it; in other words, we put them "out of our mind." As a consequence, Freud claimed, we eventually lose our awareness of them.

Freud's methods and theories have had a marked influence upon psychology, medicine, and various spheres of everyday life, even including literature and art. It should not be assumed, however, that all of Freud's ideas are scientifically sound. He developed several ideas about neurotic and normal personality which, because they are based primarily upon observations of abnormal people and appear to rest upon insufficient proof, are without adequate scientific demonstration. Many feel that Freud overemphasized the influence of sex in human life, and some of his fellow analysts differed from him in this regard. He may be credited, nevertheless, with having shown the determining influence of urges unknown to the individual and especially of urges derived from childhood experiences. The latter suggestion, as we have already seen, had a marked impact on child psychology.

Although Freud was especially concerned with understanding and helping neurotic people, his observations and concepts have influenced other areas of psychology. This, as we will see in later chapters, is most apparent in the study of motivation and personality. Many commonly used terms in these areas, like unconscious motivation and repression, stem from Freudian psychoanalysis.

### The feeble-minded

Intelligence tests, as we have seen, were first used to keep mentally incompetent children out of the French school system. Behind this there is a long history which culminated not only in the development of intelligence tests but also in the establishment of psychological

clinics to help the feeble-minded and other handicapped people.

Until fairly recent times, the feeble-minded, like the psychotic, were mistreated to "drive the devil out of them." No more than custodial care was provided, and that of the poorest imaginable kind. Eventually they were given better care and efforts were made to understand the nature of their disorders and how best to educate them.

The limited educability of feeble-minded children was revealed in a study which, at the time, received its motivation from broad philosophical issues. A philosopher named John Locke (1632-1704) had claimed that the human mind at birth is a *tabula rasa*, a blank sheet. This was a radical idea, for Plato and others had assumed that certain ideas are inborn; that is, present in the human mind from the start. Locke's *tabula rasa* concept meant that, rather than being present at birth, ideas are derived from experience. The educational implication of this doctrine seemed clear. Anybody could be made intelligent by presenting his senses with the right ideas in sufficient number. This theory induced Itard, a teacher of the deaf, to attempt the education of a "savage" boy who had been found living in the woods like an animal.

When discovered in 1798 the boy was believed to be around ten years old. He walked on all fours, ate like an animal, and made unintelligible sounds. Itard devised various ways of bringing ideas to the boy and he kept up his efforts for five years. During this time there was some progress. The boy learned sensory discriminations, to recognize some objects, to speak a few words, and to read and write a little, although with poor understanding. He also learned various motor skills. But, despite such progress, Itard's pupil did not rise above the level of feeble-mindedness. Was this because he was innately deficient? Or was he normal at birth, but handicapped by years of animal-like existence? These questions could not be answered. Thus the controversy which started this investigation was not resolved. Nevertheless, Itard had stirred up an interest in the feeble-minded and suggested that, even if one cannot educate them into normality, they can be educated to a degree.

One of Itard's followers, a man named Seguin, devised methods of training the men-

tally handicapped and, when he came to the United States in 1848, helped establish special institutions for the care and training of the feeble-minded. Seguin's formboard, along with others of which it was the prototype, is still widely used to diagnose the mental ability of feeble-minded and illiterate individuals. (See Figure 4.6, board with star, on p. 91.)

The first clinic for the study and treatment of mental and other handicaps was opened at the University of Pennsylvania in 1896 under Witmer's direction. Today psychological clinics are found throughout the world. In the United States alone there are now more than 5,000 clinical psychologists. These are working in clinics for adults as well as children. Many are in school systems, colleges, the Veterans Administration, the Armed Services, and mental hospitals and homes for the mentally retarded. Many work in close cooperation with psychiatrists.

#### Psychiatrists and clinical psychologists

Psychiatrists and clinical psychologists are jointly concerned with insane and neurotic people. The psychiatrist is a physician with an M.D. who specializes in psychological problems and is also qualified to prescribe drugs and other medical treatments. Some psychiatrists are also psychoanalysts, receiving this designation because they specialize in the use of psychoanalytic procedures.

The clinical psychologist is usually a Ph.D., although some also have an M.D. His major training and clinical experience is in psychology, with emphasis on behavior disorders. He may be accredited by a national or state board in clinical psychology.

In dealing with severe cases of mental illness such as psychoses and some neuroses, clinical psychologists work in close relation with psychiatrists. Customarily, their function here is to administer and evaluate psychological tests, thus facilitating diagnosis. In certain circumstances they engage in psychotherapy with their clients or patients.

Less serious behavior disorders, including problems of school or home adjustment, are usually dealt with in a psychological clinic. Here the clinical psychologist, although he works in close cooperation with medical doctors, is himself responsible for nonmedical as-

pects of diagnosis and therapy. If the clinical psychologist suspects the presence of a psychosis or of some glandular or other organic disorder, he sends his client to a physician for medical diagnosis. Medical doctors, when they come across nonpsychotic behavior disorders and problems of adjustment, refer their patients to a clinical psychologist. More serious disorders are referred to a psychiatrist.

of Table I.1, which gives the classification of psychological information utilized by *Psychological Abstracts*, a publication of the American Psychological Association. One can observe where phenomena already discussed find their place in the overall picture of psychology today. Theory also finds a place, and this will now receive our attention.

## SYSTEMS OF PSYCHOLOGY

Table I.1. The Interests of Modern Psychologists as Revealed by the Table of Contents of *Psychological Abstracts*

### General

Theory & Systems • Methods & Apparatus • New Tests • Statistics • Reference Works • Organizations • History & Biography • Professional Problems of Psychology

### Physiological Psychology

Nervous System

### Receptive and Perceptual Processes

Vision • Audition

### Response Processes

### Complex Processes and Organizations

Learning & Memory • Thinking & Imagination • Intelligence • Personality • Aesthetics

### Developmental Psychology

Childhood & Adolescence • Maturity & Old Age

### Social Psychology

Methods & Measurements • Cultures & Cultural Relations • Social Institutions • Language & Communication • Social Action

### Clinical Psychology, Guidance, Counseling

Methodology, Techniques • Diagnosis & Evaluation • Treatment Methods • Child Guidance • Vocational Guidance

### Behavior Deviations

Mental Deficiency • Behavior Problems • Speech Disorders • Crime & Delinquency • Psychoses • Psychoneuroses • Psychosomatics • Clinical Neurology • Physically Handicapped

### Educational Psychology

School Learning • Interests, Attitudes & Habits • Special Education • Educational Guidance • Educational Measurement • Education Staff Personnel

### Personnel Psychology

Selection & Placement • Labor-Management Relations

### Industrial and Other Applications

Industry • Business & Commerce • Professions

The *Psychological Abstracts* publishes brief digests of psychological articles which appear in every country in the world.

The scope of present-day psychology may to some extent be gauged from an examination

Science, as we have seen, is based on observation. A theory without verifiable evidence from unprejudiced observation or experimentation has no chance of scientific acceptance. Thus the scientist needs facts. But when sufficient facts have been uncovered, there is need for classification and organization. What is known must be integrated. Significant relationships must be sought. Provisional theories or predictions must be made. These must in turn be tested by further observations. The outcome of such observations leads to acceptance, rejection, or modification of the theories which they were designed to test. In this way scientists use what they know as a springboard for advances into new territory. As James B. Conant, a former President of Harvard University puts it, "Science is an interconnected series of concepts and conceptual schemes that have developed as a result of experimentation and observation and are fruitful of further experimentation and observations . . . emphasis is on the word 'fruitful.' Science is a speculative enterprise."<sup>3</sup>

Until the present century, psychologists were doing little more than asking questions and collecting a sundry array of facts about limited areas like sensory experience, individual differences, animal intelligence, child development, and normal and abnormal personality. In all of this effort there was no general plan. There was not even a generally accepted definition of what psychology is. Obviously an integration of psychological knowledge was needed, not only to pull the disconnected threads into a meaningful pattern, but also to give direction to further research. This need brought forth various "psychologies" or "schools of psychology." Although none of these achieved universal acceptance among psychologists, each served as a rallying point for various groups and gave a certain

degree of direction and meaning to their work.

In describing the origin and expanding scope of psychology, we have already touched upon two early schools (the structural and functional) and upon factors which influenced development of certain other schools.

*Structuralists* said that psychology should focus upon conscious experience as revealed by experimental introspection. They received their inspiration from Wundt. The outcome of their approach was a sort of mental chemistry. Conscious experience was analyzed and described in terms of its makeup; that is, its structural elements (sensations, images, feelings) much as matter is analyzed and described by chemists in terms of its basic structures. The structural school dealt, in a sense, with the *contents* of consciousness. One outcome, as we have seen, was a unified body of knowledge about the processes involved in knowing our world. Neurological and other physiological structures and functions which underlie these processes were also of interest to structuralists.

*Functionalists* emphasized the functions rather than the contents of consciousness. As we pointed out earlier, they were more interested in what consciousness *does* than in what it is. Theirs was, in every sense, a psychology of adjustment. In this the functionalists were, as we have seen, greatly influenced by Darwin's ideas about the struggle for existence and the survival of the fittest. Introspection was used, but behavior (from the standpoint of adjustment to the environment) came into prominence. The scope of psychology thus expanded to take in adjustment as well as conscious experience.

Present-day psychology is broadly functional in the sense that it studies adjustment of organisms to their environment. Since sensory and perceptual processes are important aspects of adjustment, these find a place in the functional approach. Within this overall functional trend, however, one finds the imprint of other schools of psychology. The most influential of these was Behaviorism.

### Behaviorism

The leader of the behavioristic movement was John B. Watson, who, from 1908 to 1920, taught at The Johns Hopkins University. Watson's training had been in the functional tradi-



John B. Watson

The principles of Behaviorism were first expounded by Watson. He also did pioneer research on animal and child psychology.

tion and he retained his broad functional orientation. But he argued for what one might call an "objective functionalism." Watson contended that psychology should give up studying conscious experience, whether in terms of its contents *or* its functions. He stressed the point that introspective data are *subjective*; that is, evident only to the experiencing individual. He could not, of course, deny that conscious experience exists. His argument was merely that since this is private, it cannot be studied scientifically. The fact that introspective reports were taken as descriptions of conscious experience did not impress him. Let us see what lay behind this attitude.

Physicists studied phenomena which any trained physicist could observe, not just privately but in common with others of similar

training. Likewise, a biologist studied other organisms, or even his own organism, through observations which other biologists could make at the same time. Observations made under such "social" circumstances are said to be *objective*. Psychologists, on the other hand, were attempting to obtain scientific data by looking inward. Watson wanted them to look outward, as the natural scientists do and, even in the case of man, to study him as an object in nature. Observations of an objective psychologist would thus be restricted to overt responses, to stimuli which arouse them, and to observable aspects of underlying physiological mechanisms, like nerves, glands, and muscles. This would be a "stimulus-response" psychology.

In taking his stand that psychology should be a science of behavior, Watson was also

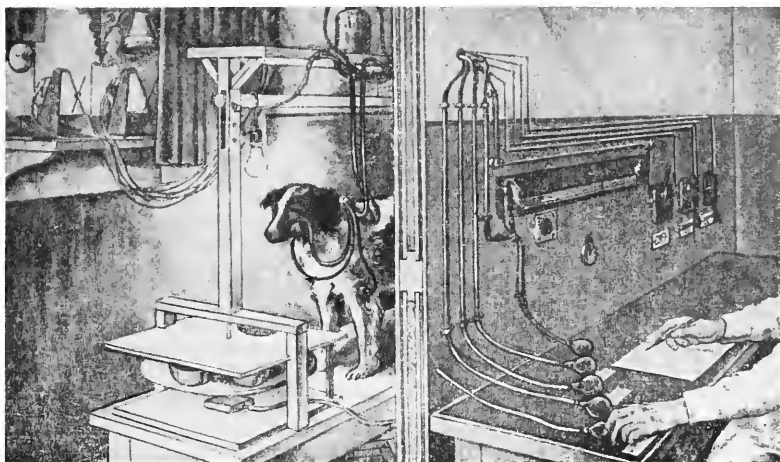
influenced by several earlier developments. Some of these have already been considered. Many psychologists were, in fact, confining their attention to behavior. Investigations of memory, of individual differences, of child development, and of learning in human and animal subjects were as objective as any in physics, biology, and the other sciences. These, and many other psychological phenomena, could be investigated without introspection and without any reference to how the individuals under observation felt about what was happening to them. In the case of animals, moreover, one could have a science of behavior even though there was no hope of obtaining reports from the organisms themselves. In fact, various physiologists were carrying out experiments with animals and human beings which did not involve introspection and which were nevertheless of great interest to all psychologists.

The best example of our last point is the work of two Russian investigators, Bechterev and Pavlov, on conditioned reflexes. Bechterev reported that the withdrawal of a limb from electric shock could be conditioned so that some previously ineffective stimulus aroused it. Thus a person shocked on the foot withdrew his foot. If a bell was rung, there was no such withdrawal. But when the bell preceded the shock by a short interval and this procedure was repeated, the bell by itself became effective in producing withdrawal. In a similar manner Pavlov had shown that a dog salivates when food is placed in its mouth but not when it is stimulated by the sound of a metronome, a flash of light, or a scratch on the skin. Through the procedure of presenting a metronome sound, then food as shown in Figure 1.8, the dog was finally conditioned to salivate when the sound started. Once the dog had been conditioned to a given frequency, another frequency was introduced. Having been conditioned to salivate in response to a beating metronome, the dog salivated to this also. However, by giving food with one frequency and withholding it when the other was presented, Pavlov induced the dog to salivate for one and not for the other. Then the difference was reduced. This was done, for instance, by increasing the frequency of the no-food stimulus. It was increased until the difference between the two stimuli was so small that the



Ivan Pavlov

Here Pavlov is shown as a medical student. It was in his later years, after he had won the Nobel prize for his work on gastric secretions, that Pavlov did the pioneer research on conditioned reflexes.



**1.8 Chamber for Studying Conditioned Reflexes.** Food was introduced into the dog's mouth mechanically from the adjoining room. This stimulated secretion of saliva, which was collected via one of the tubes illustrated. A beating metronome at first produced no saliva. It was then started just before food entered the dog's mouth. This pairing of sound and food continued until conditioned salivation occurred, i.e., until the sound alone produced salivation. (After Razran.)

dog salivated for both, or salivated for neither. In this way, without any reports from the dog, it was possible to discover how small a difference the animal discriminates. If one wished to do so, he could carry out psychophysical research by comparable objective procedures.

Watson saw in the conditioned reflex a way to circumvent introspective reports and thus obtain objective data, not on experience, but on the sensitivity of organisms to stimuli. Sensitivity in this sense implied no more about conscious experience than when we speak of the sensitivity of a light meter, a galvanometer, or a photographic film.

Enough has been said about the antecedents of Behaviorism to show that its roots were in the history of psychology itself and also in biology. Some said that the new movement was not psychology at all; that it was no more than biology. There are at least two answers to this criticism of behavioristic psychology:

(1) Psychologists are interested in adjustments of the *whole organism* to its environment, whereas biologists are preoccupied with particular biological processes such as circulation, digestion, and heredity. This distinction, while correct in general, falls down when, as often happens, biologists study overall adjustments like the nest-building of birds and psychologists study partial reactions like reflexes. All that can be said in favor of such a distinction is that, from the standpoint of the relative emphasis given to part and whole reactions, psychologists are more concerned with the latter.

(2) Psychologists study behavioral processes to which biologists, as such, give little or no attention. One can see this by comparing a biology and a psychology textbook. Generally speaking, the concern of biologists is primarily with unlearned (innate) processes; that of psychologists with learned (acquired) processes.

Biologists, for example, give no more than passing attention to such aspects of life as memory, learning, problem solving, and individual differences in intelligence and personality. They are not especially concerned, as psychologists are, with the development of behavior in children, behavior of human beings in groups, and psychological aspects of adjustment such as fall within the province of clinical psychology. Our point is not that the interests of biologists and psychologists are foreign to each other. Indeed, they frequently overlap. It is merely that those who regarded behavioristic psychology as *nothing but* biology were incorrect.

Watson began a trend which has culminated in the modern preoccupation of psychologists with behavior, studied by methods as objective as those used in the natural and physical sciences. It is interesting to note in this connection that modern psychology, as frankly objective as it is, leaves out very little that has been derived from other approaches. In fact, it embraces much that was formerly dealt with from the standpoint of experience. Some suggestion of this was given in the discussion of conditioned reflexes, where we pointed out that sensory processes (but not experiences) can be studied objectively. The ability of an objective psychology to encompass data which were previously considered from a so-called subjective standpoint can be further illustrated in this way: Suppose that a colored signal light is flashed. The objective investigator is not interested in your experience — for that is private, known only to you. He may be interested, however, in the fact that you respond to the light and that you, like himself, distinguish one color from other colors; for example, by altering your response as the color changes. You say “red” or “green,” or you press one button for red and another for green, or you step on the brake for a red light and on the accelerator for green. The investigator of behavior is satisfied to demonstrate that an organism distinguishes two lights, as above. He believes that nothing is added to our scientific understanding by saying that the lights produced different conscious experiences.

Before leaving Behaviorism as a school, it is well to make a distinction between behavioristic methodology, which is what we have been discussing, and Watson’s materialistic

philosophy, which did much to bring criticism upon this movement. While arguing that psychologists must restrict themselves to the facts revealed in their observations and experiments, Watson went considerably beyond the observable facts himself. His theories went beyond the facts in various areas, as will become apparent in some later discussions. Especially disturbing to some, however, was his claim that Behaviorism demanded a materialistic philosophy. While many psychologists accepted the concept of psychology as a natural science of behavior and, accordingly, its objective methodology, they rejected as philosophically naive the idea that because psychologists must limit their observations to such apparently material things as stimuli and nervous and muscular reactions, they are forced into a materialistic philosophy. The present-day psychologist with behavioristic leanings, who is known merely as a *psychologist*, might embrace any philosophical or religious viewpoint. This is because behavioristic psychology is for him a methodology, a means of discovering information about behavior and in no sense a concept of the nature of ultimate reality. For practical purposes in carrying on his investigations, any scientist must treat what is before him *as if* it were material, but he has no more notion than anyone else as to what, if anything, lies beyond the range of his senses, even when these are amplified by such instruments of science as microscopes, galvanometers, and electronic devices. As a scientist he can neither affirm nor deny any particular theory or doctrine of ultimate reality. Nor should he be expected to do so, any more than a physicist, a chemist, or a physiologist. Objective psychologists, like individuals in other sciences, actually vary a great deal from one to the other with respect to their philosophical or religious beliefs.

### Gestalt psychology

This school developed in Germany around 1912 under the leadership of Wertheimer, Koffka, and Köhler, all of whom came to this country and continued their work here. Wolfgang Köhler has been the chief spokesman for this group. Gestalt psychology is, in many respects, a protest against certain aspects of both structural and behavioristic psychology.



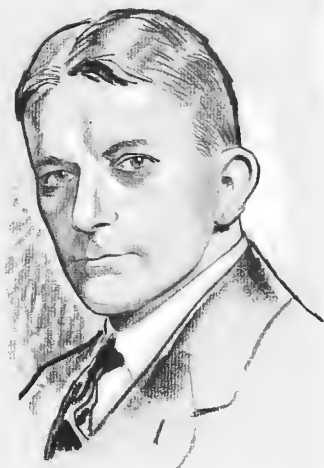
The word "*Gestalt*" may be translated as "form" or "configuration." Those who follow Gestalt principles are, in fact, often referred to as *configuralists*. The term *holistic* is also applied to certain configurationally oriented studies, the reason being that these emphasize the *whole person*, or the *whole situation* in which he adjusts. Those who hold this general position disparage analytical or piecemeal investigations.

Gestalt psychologists argued that analytical (molecular) procedures such as the structuralists used are artificial and that what is revealed does not represent the true nature of conscious experience. Perception, for example, was said to be more than the sum of sensations and other elements revealed by experimental introspection. It was felt that one should begin with the complex; that wholes come first and parts have little or no meaning except when considered with respect to their place in the whole. Behaviorists were criticized for their study of isolated behavior segments; such, for example, as conditioned reflexes. Pavlov and some behaviorists had argued that habits are chains of conditioned reflexes, one reflex in the series serving as a stimulus to set off the next. To configuralists, however, behavior is more than a "bundle of reflexes."

Gestalt psychologists demonstrated that animals and men learn certain things which defy a piecemeal analysis. In doing this they introduced some new concepts to the areas of psychology concerned with learning and thinking. This influence becomes evident in later discussions.

It is interesting to observe that Gestalt psychologists studied animal and child behavior as well as perceptual experience. One should also note that some behavioristic psychologists, without deserting their overall functional and objective position, were led through the influence of Gestalt psychology to study and interpret behavior in accordance with configural principles. This school has also had a marked impact on our conception of how behavior develops and even of how the brain functions.

There were of course other schools of psychology, but an introductory text is not the place to discuss all of them. The most prominent of those we have failed to discuss, as



**Wolfgang Köhler**

One of the founders of Gestalt Psychology who later became a professor at Swarthmore College, Wolfgang Köhler served as President of the American Psychological Association in 1959.

schools, is *psychoanalysis*. Under Freud's leadership this was indeed a school, but psychoanalysts have separated into a variety of groups so that now there are several psychoanalytical schools. All are definitely holistic in their general approach and all are concerned with personality and with what moves us to behave as we do, but beyond that they differ markedly. As we have already pointed out, psychoanalysts differ among themselves with respect to the importance of sexual motivation. There are many other differences, not only in concepts, but also in clinical procedures.

The major scientific contribution of psychoanalysts has come from their introduction of concepts which suggested new approaches to the study of human behavior. Some of these, as later discussions of motivation and personality will show, have been susceptible to

verification through experimental studies with children and adults, and even with white rats.

Each of the schools changed psychology a great deal—with respect to its scope, its methods, and its theoretical orientations. Some of them, after leaving an indelible imprint, passed out of focus. Today these schools, insofar as they may be said to exist at all, are more or less peripheral. The emphasis today is on *psychology*. Rather than allowing themselves to be classified as Structuralists, Functionalists, Behaviorists, or Configurationalists, most students of behavior prefer to be known merely as psychologists. With respect to overall methodology and fact there is, today, little controversy among them. Their attitude is that any approach which adds to our understanding of human behavior is worth while. Where scientific methods are used, the facts, once verified, are of course beyond dispute. The only possible argument is about our interpretation of these, and this is where the so-called “miniature systems” of psychology come into the picture.

#### Miniature systems

Whereas schools of psychology attempted an overall integration of psychological knowledge, miniature systems have been much less ambitious. They have dealt with restricted areas of psychological investigation.

Most of the current miniature systems focus upon the learning process. Starting with certain well-established facts about learning, the proponent of a particular theoretical approach conceives of underlying or unifying principles which offer the possibility of explaining these facts. After formulating his theoretical explanation, the investigator sees that, if his theory is true, organisms tested under certain conditions ought to yield such and such results. He or his associates then test the theory by carrying out the projected experiment. If the outcomes are as predicted, this is of course a point in support of the theory. If results are not as predicted, then the theory must be discarded, or at least modified to take the negative findings into consideration. One such theory has given rise to many investigations, some of which have supported it and others not. The theory to which we refer is still

being modified as a result of research findings.

Through theories like this, even though they may turn out to be incorrect or inadequate, we obtain facts of relevance to our understanding of behavior. We thus advance the frontiers of knowledge.

It is important to remember, in the above connection, that a scientific theory is useful only if we can test it and that it stands or falls or undergoes modification in terms of relevant facts. There is a marked contrast between this approach and acceptance of a theory because some great man propounded it, or because, in thinking about the theory, it seems reasonable to us.

We said that miniature systems are less ambitious than were the “schools” of psychology. This is true with respect to their immediate scope. However, it is possible that the final outcome will be an all-embracing theory enabling us to understand and predict every aspect of human behavior. Today, as we have said, much theoretical discussion centers around the nature of learning. The reason for this is that almost everything that man does is learned. Thus, if we understand the learning process in its many details, we will also understand, to a very large extent, why man behaves as he does.

The psychologist, instead of viewing man first of all from the standpoint of his social, esthetic, intellectual, or religious life, sees him primarily as an object in nature. This point of view does not deny or try to explain away man's highest attributes, but rather aims to describe the sort of creature that is capable of having the modern man's intellectual, social and spiritual life.<sup>4</sup>

#### GENERAL PSYCHOLOGY

General psychology, the province of this textbook, cuts across various fields and systems to give a survey of scientific psychology as it exists today. Although diverse points of view receive attention from time to time, and different methods of investigation are discussed, our survey is largely factual.

There are various ways in which psychological information can be organized. In this text we have sometimes used the theme of development, tracing the evolution of behavior in different representative organisms and then

its growth in the human individual from conception until old age. Psychological knowledge can also be dealt with in terms of major psychological processes, like motivation, learning, and perceiving. In some sections we have used this approach, presenting a survey of what is known about such processes. Other information has been organized around the theme of individual differences, concentrating from this standpoint upon differences in intelligence and personality. Since social interaction plays an

important role in human life, two chapters are devoted to it. One of these deals with collective behavior and the other with language and communication.

Although certain applications of psychology are discussed in relation to development, sensory processes, individual differences, collective behavior and communication, a final section of this text deals with what psychologists are doing to improve human efficiency in aspects of everyday life.

## Summary

Beginning its scientific career as an attempt to analyze consciousness, psychology gradually broadened its scope and, in doing so, became a science of behavior.

Certain studies in physics and physiology which had obvious relevance for psychology led Wundt to start a separate science of psychology. The source of data for this new science was experimental introspection by trained observers. Investigators in Wundt's laboratory and others outside of it soon extended psychological observation to individual differences, memory, and the learning process. Animals and children began to play a part in psychological research. Psychologists also extended their investigations to abnormal people—the psychotic, the neurotic, and the feeble-minded. Freud, a leader in the study of neuroses, founded the school of psychology known as psychoanalysis. By this time there was much less emphasis upon consciousness and the introspective method and more upon behavior. In the course of these developments, many general fields of psychology began to emerge. For example: findings on memory, the learning process, child behavior, individual differences, and mental testing were of obvious practical value to education, hence they became the backbone of educational psychology. The field of clinical psychology grew out of work on child development, abnormal behavior, and mental testing. Today there are many other fields—usually of multiple origin like those mentioned. Among these are industrial psychology, vocational psychology, and social psychology.

As psychological information accumulated there were efforts to pull the threads together—to integrate what was known and to plan meaningful research for the future. Thus several so-called “schools” or “systems” of psychology arose. Psychoanalysis was such a system, only it focused rather directly upon personality and behavior problems. Another school, taking its origin from Wundt and his interest in the structure of consciousness, was known as structuralism. Functionalists envisaged their task as that of discovering how consciousness facilitates adjustment. They were influenced in this by Darwin's concept of evolution. But consciousness proved so elusive that investigators finally concentrated their attention on the learning process without reference to its conscious aspects. Behaviorism, which emphasized the objective as against the subjective approach to psychological problems, was influenced by functional studies of learning, by earlier work with animals and children, and by the conditioned-response studies of Russian investigators. Gestalt psychology, dealing with aspects of experience as well as behavior, emphasized the holistic as against the extremely analytical approach of earlier schools. Each of these systems integrated what it could and pushed into new territory. Thus each left an indelible mark upon modern scientific psychology. The newer systems, referred to as “miniature” because of their relatively narrow scope, grew out of the earlier schools. These focus upon particular psychological functions; for example, the learning process.

Psychology today is best defined as the science of behavior. It emphasizes the objective approach so characteristic of the other natural sciences. However, it is to some extent a social as well as a natural science. This is because living organisms, and especially hu-

man beings, are influenced by the behavior of those around them.

The next chapter takes us more deeply into the methods used by psychologists in their search for a scientific understanding of behavior.

(References and notes for this chapter appear on page 543 of the Appendix.)

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# *The Scientific Study of Behavior*



2

Questions asked by psychologists • Sources of psychological information  
• Experimental research • Psychological experiments • Statistical procedures • Summary

Students often ask whether psychology is really a science. They know that astronomy, geology, physics, chemistry and biology have traditionally been called sciences. As compared with the subject matter of these sciences, however, psychological phenomena seem so different, so intimately involved with oneself. Moreover, psychological problems were so long dealt with philosophically rather than scientifically, that a genuine doubt concerning the scientific status of psychology naturally arises. Even in colleges and universities, psychology is sometimes classified with the humanities and sometimes with the social sciences. Our earlier discussion indicated that psychology is a natural science which has close ties with biology and with social sciences like sociology and anthropology.

The scientific status of psychology comes from its use of scientific methods, some aspects of which were considered briefly in the preceding chapter. The essence of a scientific approach is admirably summarized by Warren Weaver, a recent president of the American Association for the Advancement of Science. He says: "Scientists have learned by experience that it pays to stop and think; that it is sensible to suspend one's prejudices and try to find out what the relevant facts are; that trying to decide what is relevant is of itself an illuminating procedure; that if the facts, as determined under sensibly controlled conditions and by competent persons, run contrary to tradition or hearsay or the position of arbitrary authority, then it is necessary to face

and accept the story which is told by the facts; that logical precision in thinking is very useful when one is dealing with the more quantitative aspects of experience; that high standards of personal honesty, open-mindedness, focused vision, and love of truth are a practical necessity if one is going to be successful in dealing with nature; that curiosity is a worthy and a rewarding incentive; that nature is orderly and reasonable, not capricious and mad, with the result that it is possible to attain greater and ever greater understanding of the world about us." <sup>1</sup> Here we re-examine scientific methods but with special reference to the subject matter of psychology.

Whatever his specific field of interest may be, a psychological investigator is systematic in his approach. He begins by asking questions which, in view of what is already known about behavior, appear significant to him. He not only asks questions; he seeks answers to them. Instead of appealing to authorities or engaging in unbridled speculation, he answers his questions by gathering relevant facts — by, as it were, "going to the horse's mouth."

Facts may be obtained in various ways. Sometimes the investigator gets them from field observations such as a naturalist makes. More often he gets his facts from carefully arranged experimental situations. But even the field observer may introduce experimental variations and, by so doing, obtain explanatory information not otherwise available.

Although psychological research is basically similar to that in other sciences, the complexities of behavior give rise to unique methodological problems. Behavior at the adult human level is particularly complex and those who attempt to understand its intricacies must surround their experiments with checks and balances (controls) having no parallel in the research of other natural scientists. Some such controls are described in this chapter.

We begin by referring to typical questions which psychologists ask. Sources of relevant information are then described and psychological methods are illustrated by reference to particular studies in which they have been used.

#### **QUESTIONS ASKED BY PSYCHOLOGISTS**

An investigator's questions will, of course, depend upon the area that is of interest to him, his background, and the particular problem or problems confronting him. This is so whether the problem is satisfaction of his curiosity about some aspect of behavior, the testing of a particular hypothesis, or the solution of some immediately practical issue. Thus questions may be theoretical (having to do with fundamental principles) or they may be practical (designed to solve particular problems of everyday life).

##### **Theoretical questions**

Questions of a theoretical nature are: "What is it?" "How does it come about?"

"Why does it occur?" In psychology, "What" questions are framed more specifically as follows: "What is thinking?" "What is perception?" "What is intelligence?" or "Upon what sense is such and such behavior dependent?" Typical "How" questions are: "How do we learn?" "How do we hear?" and "How does personality develop?" Sample "Why" questions are: "Why do we forget?" "Why do some people learn faster than others?" or, in the most general sense, "Why do we behave like human beings?" Other representative questions in psychology are: "Is reasoning especially dependent upon a particular region of the brain?" "Is there any relation between body build and personality?" "Are fast learners quick or slow forgetters?" "Do animals think?"

In testing a given theory, the investigator

first hypothesizes that, if this theory is correct, an experiment designed in a certain way will have a particular outcome. His question then is: "Will I obtain the predicted outcome?" If his hypothesis is a relevant one and if the outcome of the experiment is as predicted, the theory receives a certain degree of support.

Answers to theoretical questions may, and often do, have practical significance. Principles derived in answering such questions may be applied to the solution of everyday problems. Thus, educational psychology applies principles of learning, child guidance uses principles derived from child psychology, and industrial psychology employs principles derived from sensory, physiological, and other areas of experimental psychology.

### Practical questions

Questions of a directly practical nature are: "Why do some people have many more accidents than others?" "What makes a child delinquent?" and "How may shorthand be taught more efficiently?" Knowing the answers to such questions puts us in a position, for example, to reduce the frequency of accidents, to prevent delinquency, and to reduce the time and effort required in teaching shorthand. The latter, and countless other problems aimed at the solution of practical issues, may be investigated just as scientifically as any theoretical problem. Facts obtained in such investigations, moreover, may enlighten us concerning theoretical issues. A study on the teaching of shorthand, for instance, may throw additional light on principles or theories of learning.

### The developmental approach

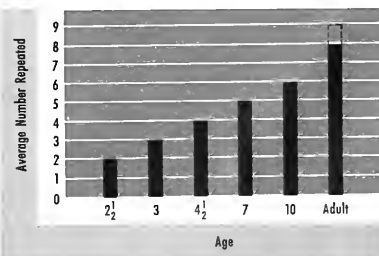
In addition to classifying questions as theoretical or practical, we may consider them from other standpoints. One such approach is that of *comparative psychology*, so called because it involves comparison of the behavior of organisms at different levels of evolution. Here questions like these are asked: "How does the learning of ants compare with that of rats?" "At what level of evolution does reasoning appear?" and "Is human learning different in kind or only in degree from that

of other organisms?" This approach deals with phylogeny, that is, with racial development, hence it is referred to as phylogenetic. Another developmental approach is concerned with the growth of behavior at different age levels in a particular organism; that is, with ontogeny or individual development. Relevant questions here are: "How does memory change as a function of increasing age?" (Figure 2.1); "What is the relation between age and learning ability?" and "How is adult personality influenced by childhood experience?" As a matter of fact, the scope of the ontogenetic approach may embrace not only childhood and adolescence, but also adulthood, later maturity, and old age. Both the phylogenetic and ontogenetic fields comprise what is known broadly as *developmental psychology*.

Developmental psychology focuses on *trends* rather than processes as such. Nevertheless, investigators of psychological development use methods which are fundamentally the same as those used by other psychologists. These may be naturalistic or experimental. Using an experimental method, tests of learning ability may be given at various animal levels (rat, dog, monkey), or at various age levels (child, adolescent, senescent). Then, after all of the data are in, changes in ability from lower to higher organisms or from childhood to old age may be plotted.

Any psychological process may be studied from the standpoint of its evolution in the

**2.1 Growth of Memory with Age.** The height of the bar represents the average number of digits repeated after hearing them once. Adult scores range from 8-9. (Data from Terman and Merrill.)



animal kingdom or its development in the individual and there are decided advantages to be gained from such investigations. The value of normative studies of child development were mentioned earlier. Apart from such obviously practical outcomes of the developmental approach there is also the possibility that knowing how we got to be what we are will put us in a better position to understand ourselves.

### **The clinical viewpoint**

Clinical psychology is another approach, with its own questions. Clinical psychologists, as mentioned earlier, are concerned with the prevention, diagnosis, and treatment of behavior disorders in particular persons. They want to know what is wrong with an individual and what to do about it. The question, "What is wrong with Mary Smith?" may be answered, in part, by giving her certain psychological tests. If he is to help her solve her problems, however, the psychologist may need to know the basis of her present difficulties. Perhaps she was overprotected as a child. Perhaps, on the other hand, she was neglected. Perhaps the nature of her home life produced a feeling of insecurity. Perhaps she had insufficient contact with other children of her own age. Perhaps her parents expected more of her than she could accomplish. Information about such possibilities must come from an examination of Mary's past and a reconstruction, so to speak, of her life history. Knowing how she got to be what she is can aid the clinical psychologist both in diagnosing her difficulties and in helping her achieve a better adjustment. Here we also observe the practical value of a clinical approach which is at the same time developmental.

We have seen that the pursuit of psychological facts is systematic rather than haphazard. It is guided by relevant questions. Some are practical, having to do with human adjustment. Others are theoretical, involving queries about processes which underlie behavior. The pursuit is also systematic in that it focuses upon a particular process, or the development of that process. Moreover, one may be concerned with principles or with clinical problems, those relating to the adjustment of a particular person.

## **SOURCES OF PSYCHOLOGICAL INFORMATION**

Where we look for information and how we obtain it is to a considerable extent dependent upon the questions to be answered or the issues to be settled. If these are about conscious experience, we must ask people to describe what they experience. As subjective as this is, even when done under experimental conditions, it is our only source of information on such phenomena as feelings, dreams, and past experiences. Because this information comes through speech (verbal behavior), we say that it is derived from *verbal reports*. Verbalization is also an important source of clinical information. The client describes his fears, his feelings, and his delusions. The psychoanalyst uses verbal information. He listens to what the patient says while free-associating, or while describing his dreams.

### **The case history**

In reconstructing the individual's past, clinical psychologists obtain a case history or biography. This is derived from interviews with the individual himself, his parents, his teachers, and various other associates who may be able to provide significant information. Public records (school grades, juvenile court appearances, etc.) may also provide important information. Biographical information is often gathered by social workers who have had special training for the task. When finally assembled, the case history includes information about early training, parental attitudes, social status in school and community, and what has been obtained from talking with and testing the individual. The ultimate aim of such a study is, as we have said, to reveal sources of trouble and to suggest ways of correcting them. Figure 2.2 shows what may be involved in a case history.<sup>2</sup>

### **Information on child behavior**

A child psychologist may want to know, for instance, how children at different age levels express anger. Anger might be elicited under experimental conditions, but this approach is not used with children. Apart from undesirable effects that an experimental study



**2.2 A Case History.** Tommy, a ten-year-old, is caught in the act of stealing from his teacher's handbag. Fortunately, he lives in a community that has an excellent Child Guidance Clinic staffed by a psychiatrist, a clinical psychologist, and a social worker. The school principal talks with Tommy's mother, who thinks at first that there must be some mistake, that it couldn't have been her child. She learns that it was indeed her Tommy, and then she consents, not only to have him go to the Clinic, but also to go there herself for help. The psychologist (top) gives Tommy several tests including pictures about which he is to make up stories. The test results, including Tommy's drawings and what he has to say about his relations with other children, show him to be filled with hostility toward his family, his teacher, other children, and the world in general. His stealing is a hostile act directed at the teacher. It is discovered that he has also stolen from his mother. In addition, hostility comes out in therapy sessions with the psychiatrist (center). In one of these, while shooting rubber darts at a target, Tommy misses and hits the psychiatrist in the head. This particular hostile episode is precipitated by the asking of a question he did not like. While Tommy has frequent sessions of play therapy with the psychiatrist, his mother (bottom) is interviewed by the social worker. These interviews reveal that the home environment is largely responsible for the hostile streak in Tommy's personality. His mother has always been dominated by her mother (who lives with them and interferes constantly). Her own hostility toward her mother is directed toward her husband. She dominates him and uses Tommy to this end. Among other things, Tommy is a victim of motherly overprotection. Tommy develops a strong attachment for the psychiatrist who helps him better understand his motives. His mother is also led to see how her hostility toward her mother and her husband, her overprotective treatment of Tommy, and the family tensions engendered by these features of Tommy's home life have led him to "act out" his hostility by such antisocial behavior as stealing. Tommy's parents, with help from the clinic, undertook to change the home environment. In the process Tommy goes off to camp. The problem is not solved, but a good start toward its solution has been made. (Based upon the film "Angry Boy," sponsored by the Michigan Department of Mental Health and distributed by the International Film Bureau, Inc.)



of this kind might have on the children themselves, it is more important for practical purposes to study anger as it normally occurs. One way of doing this is to train mothers so that they can make objective reports on anger observed by them. The mothers may be trained to make an inventory of anger outbursts and to check off, on a list of possible reactions, how their children expressed this emotion. The data derived from many such reports are collated and analyzed statistically. Much information on emotion and other processes in children has been gathered in this way. Parents have likewise reported on the methods used to pacify their angry offspring as well as the success of these methods. Such information is of course valuable to other parents. Similar methods have also been used to obtain information on, for example: when the first word was spoken and what it was, the size and nature of the vocabulary at different age levels, the age at which words were first grouped into phrases or sentences, the age at which unaided walking first appeared, the nature and prevalence of fears (as for animals or strangers), and the age when affection, sympathy, and other social reactions emerged. Naturalistic observation is our only source of this information. If such studies are systematically and objectively carried out, the data derived from them are of great scientific and practical value.

Suppose, on the other hand, that we wish to know about the social behavior of children. We may arrange play sessions under standard conditions and have trained observers rate or otherwise estimate the sociability of each child. The child may be rated, for example, in such categories as: (1) plays by self, (2) merely looks on, (3) joins group but does not play, (4) plays in group but does not cooperate, (5) cooperates with others in joint enterprises. Variations of this general approach are used to study adult as well as child behavior.

#### Observations of adult interaction

Information on social behavior is obtained by arranging experimental situations, perhaps along the lines just described, or by observing interaction as it occurs naturally in audiences, crowds, or other groups.

Behavior of large groups must be studied as it naturally occurs. Experimental studies of social interaction must almost inevitably involve small groups. Sometimes the introduction of experimental techniques, even with small groups, may distort what we want to study. This is especially true when adults can discern that they are under observation.

Outcomes of social investigation may be quantitative or merely descriptive. *Quantitative* data have to do with quantities, such as the number of people involved, the time consumed in achieving some result, or actual performance scores. For example: we may study experimentally the influence of a co-working group on individual performance of some task. The scores may represent how much work was done, how many errors were made, or how many solutions were achieved. Such scores are compared for (1) alone and (2) group conditions. When naturalistic observation is our only source of data, the information is usually *nonquantitative*. It involves general descriptions such as: the people became silent, they screamed, they applauded, or they rushed toward the scene of the disaster.

#### Information on animal behavior

This information, like that on social interaction in groups of human beings, may come from naturalistic or experimental observations. Information about the social, sexual, and other reactions of free-ranging animals is purely naturalistic. The observer arranges a blind so that the animals will not be disturbed by his presence. He then describes and, where possible, photographs their activities. Movies and tape recordings are especially helpful, because the behavior can then be studied at leisure, both by the original observer and others. Much information of this kind is available on a wide range of animals from insects to gorillas. Sometimes, as illustrated in Figure 2.3, individuals are marked so that the investigator can identify them, thus note individual reactions.

#### Naturalistic and experimental observation

Experimental investigations with animals are similar, in general, to those carried out

## 2.3 Studying Social Behavior in Penguins.

Rings are placed on the flippers of those whose individual behavior in the group is to be studied in detail. Separate ringed birds are identified by the numbers painted on the rings. Note, for example, that the bird in the foreground center is No. 16. These numbers can be read even at a great distance by use of binoculars. (From W. J. L. Sladen: *The Pygoscelid Penguins. Falkland Islands Dependencies. Survey Scientific Reports*, 17, London: H. M. Stationary Office, 1957.)



with children or human adults. One difference, of course, is that we can obtain no verbal information from animals. Another is that we often have a greater control over their heredity and environment than in the case of human subjects. Still another difference is that we can operate on animals to discover the neural or physiological bases of some aspect of behavior whereas such operations would not be done on human beings except for medical reasons.\*

Although naturalistic observation is often the only source of information on certain aspects of animal and human behavior, it has marked shortcomings. It tells us *what* is happening but provides little or no information on why or how the behavior in question occurs. Answers to these questions must come from experimental investigation.

\* Where operations on animals are carried out for experimental purposes, they are done under anesthesia so as to prevent possible suffering to the subject. The American Psychological Association has a committee on precautions in animal experimentation and has formulated definite rules about the care and use of animals for experimental purposes.

*Observation of the blind.* Take, for example, the well-known fact that blind people have remarkable ability to perceive silent obstacles before making contact with them. Anybody can observe for himself how a blind man, in approaching an obstacle, slows down before reaching it and detours so as to avoid a collision. But how does he perceive the presence of the obstacle? That is not evident. The blind themselves, although they may agree with one theory or another, have no sure knowledge of how they do it. Indeed, there have been many theories, the most prevalent of which was that the blind have an unusual sensitivity of the facial skin and nerves which enables them to perceive pressure changes as an obstacle is approached. For example, one blind subject said that he felt the nearness of the object on his forehead. He was subscribing to the above theory, the theory of so-called "facial vision."

A relatively simple series of experiments with blind and blindfolded seeing subjects settled this issue once and for all.<sup>3</sup> It demonstrated, in the first place, that seeing subjects who are blindfolded can also avoid obstacles, although not as accurately as the blind. In



A



B



C

**2.4 Control Experiments to Test the Use of Touch and Hearing.** A. Notice that the subject's head and shoulders are covered and that he wears gauntlets. B. A constant 1000 cycle tone stimulates the ears. Now, as shown in picture C, the subject walks into the screen. (From Supo, Cotzin, and Dallenbach, 3.)

the second place, it showed that covering the skin with felt, as in Figure 2.4 (A), thus removing the possibility of "facial vision," did not seriously interfere with perception of obstacles. Although this research discredited the aforementioned theory, it still left unanswered the question, "How do they do it?"

Earlier research with bats<sup>4</sup> had demonstrated that they emit vibrations of higher frequency than our ear can pick up, and that these vibrations, reflected back (radar-fashion) from obstacles, enable them to fly in the dark without hitting anything. This suggested that blind people might use reflected sound to avoid obstacles. Subjects were therefore tested with their ears blocked, or while wearing headphones, the latter emitting a hum which would prevent response to echoes (Figure 2.4, B). Under both of these conditions there was a dramatic change in behavior. Blind subjects who had approached a partition confidently, and had avoided it, now were hesitant. Moreover, they no longer perceived the partition before colliding with it (Figure 2.4, C).

Thus it became apparent that hearing and not skin sensitivity is responsible for obstacle avoidance in the blind. This was further borne out by the observation that blind-deaf subjects are unable to perceive obstacles from a distance. A later experiment demonstrated, moreover, that high-pitched sounds reflected from obstacles provide the important cues for avoidance in hearing subjects. These sounds come from footsteps, breathing, and sources

in the environment.

Thus a series of experiments, supplementing what naturalistic observation could indicate, disproved a widely held theory and also provided the correct answer to the question, "How do the blind perceive obstacles?" This knowledge can be used to provide better methods of training the blind.

*A fish experiment.* The advantage of experimental procedure supplementing the naturalistic may be illustrated in many ways. However, one more illustration will suffice. This is taken from fish behavior.<sup>5</sup> The male three-spined stickleback (Figure 2.5) exhibits in the mating season a complicated behavior pattern during which he constructs a nest and then induces the female to enter and deposit her eggs. This mating pattern, alike in all these fish, has been described in detail; but what aspect of the female is responsible for starting it? The answer was obtained by introducing models which resembled in various ways the configuration of a female about to lay eggs. In this way it was discovered that the male responds to the female's swollen abdomen. Models which look like a fish but do not have this feature are ineffective and a model which does not look much like a fish but which has a swelling in about the right place sets off the characteristic mating behavior.

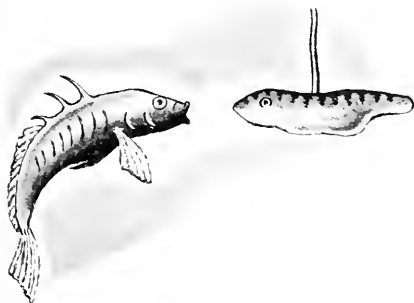
In these and in many other ways, the introduction of experimental conditions may reveal what would otherwise elude the observer of behavior under field conditions.

## EXPERIMENTAL RESEARCH

Although other methods are often used by psychologists, experimentation is of basic importance. One reason is that it allows maximum control over the phenomena under investigation. Another reason is that it provides ways of measuring the factors involved.

To say that we have *control* over phenomena means that we can produce them whenever we wish and make them vary in such a way as to force an answer to our questions. How do the blind avoid obstacles? To answer this question, as we have seen, the blind are confronted with obstacles and their behavior observed. Different kinds of obstacles are used and these are placed in whatever positions or at whatever distances the experimenter desires. The cues received by the subject are also varied at will. A subject now receives sound cues, now he does not. Through controls of this nature an investigator observes the behavior whenever he wishes to do so and he also has a means of discovering the necessary conditions for its arousal.

**2.5 Mating Behavior in the Male Three-Spined Stickleback.** A model which faithfully simulates a female but which does not have the abdominal swelling is relatively ineffective. On the other hand, a model which does not look much like a stickleback, but which has a swelling in the abdominal region, is quite effective in eliciting courtship reactions. (From N. Tinbergen, *Social Behavior in Animals*. Wiley, 1953, p. 27.)



## Measurement

By saying that experimentation provides for *measurement* of the factors involved we mean that it allows us to specify the extent or magnitude of these. In the case of the blind, one may observe that, under specified conditions, they either do or do not avoid an obstacle. One may also make measurements of greater precision than this. For example, he can measure in inches how near the person was to the obstacle before perceiving its presence and how near he came before feeling that contact was imminent. In a maze situation (p. 11) the progress of learning may be measured in terms of the number of errors per trial, the number of seconds required to get from entrance to exit, or the total distance traveled. The performance of one subject may be compared with that of another in terms of total errors or number of correct responses. In a memory experiment (p. 31) measurements may represent the number of items recalled after a specified interval. With a chronoscope (p. 9) the individual's reaction time is measured in fractions of a second. When tests are used, one measure of success is the number of items correctly answered.

The above are measures of response. But the arousing circumstances in experimental situations are also measurable. The intensity or the pitch of a sound which enables the blind to avoid obstacles may be specified in physical units. In the maze situation, not only can we indicate the precise dimensions of the apparatus, its illumination, and other surrounding circumstances, but we can also, in terms of how many hours the subject has been without food, specify the degree of its hunger. If we are studying the relation between learning and hunger, measurements like these are essential.

Many other measurements involved in experimental research will become apparent in later discussions. It is sufficient at this point to recognize that measurements of various kinds are possible, and even necessary, and that these may be either of the situation or of the responses aroused by it.

Research in psychology is concerned largely with manipulations of stimuli and measurement of the resulting responses. It is well,

therefore, to examine the concepts of stimulus and response more closely than in our discussions so far.

### Stimulus and response

Anything which initiates an organic activity is referred to as a *stimulus* — the Latin word for spur. This term is used very broadly, however, referring sometimes to a precisely specified and measured energy change (like the wave length or intensity of light) and sometimes to a general situation (like someone yelling that the theatre is on fire).<sup>\*</sup> In either instance, the “stimulus” is the antecedent event; that which initiates an activity (whether the activity is contraction of the pupil of the eye, the subject’s statement that he sees red, or rushing toward the door of the theatre). Any activity that is known to be dependent upon the stimulus is said to be a *response* to that stimulus.

In the most general sense, psychologists deal with responses of organisms to stimulation. This fact is usually represented by the symbols  $S \rightarrow O \rightarrow R$ , where S represents stimuli; O the organism; and R the organism’s response. Sometimes a formula like  $R = f(O, S)$  is used, meaning that response is a joint function of the organism and stimulation.

The psychological investigator varies stimuli (as in the obstacle experiment with the blind) and he varies conditions within the organism (as when he studies the effect of different degrees of hunger on learning). Usually he is interested in measuring the effect of such variations on the organism’s behavior. Sometimes, as we have seen, the investigator observes a response and asks, “What is the stimulus?” or “What stimuli are significant in eliciting this response?” He knows the organism and he observes the response, but his task now is to complete the psychological equation by filling in the value of S. The experiments with the blind, as well as those with the stickleback, were of this nature.

<sup>\*</sup> Nevertheless, even in the case of yelling, the stimulus could, if necessary, be reduced to the physical terms used in the measurement of energy. It is indeed always true that when objects of everyday life are called “stimuli,” a careful study of them will show that they involve measurable energy able to act physiologically upon sense organs.

Stimulation may be *external* to the organism or it may be *internal*. Since both kinds of stimulation are of great importance in psychological research, we shall say something about the nature of each.

*External stimuli.* These are those in the external environment; those which impinge upon the organism’s external sense organs. Light waves, sound waves, odorous substances, mechanical pressures, and temperature changes are of this nature. Such changes are sometimes referred to as *sensory stimuli*. Nevertheless, in order to have a stimulating effect, anything external to the organism must produce changes in its sense organs. That is to say, light waves are not stimuli unless or until they affect the eye. We often speak more specifically of *visual* or *auditory* stimuli, thus naming the stimulus in terms of the sense organ affected.

Spoken or written words are referred to as *verbal stimuli*. The people around us who affect our behavior are said to provide *social stimuli*, thus differentiating this source of stimulation from the nonsocial (or merely physical) sources. In all such cases the actual energy that acts on the sense organs is describable in the technical terminology of physics and chemistry as indicated in the preceding footnote.

*Internal stimuli.* Internal stimuli, those originating within the organism, can seldom be specified as clearly as the external, yet these are of great importance for behavior. Hence, in psychological research, internal stimuli must often be controlled. A lowering of blood sugar, such as an injection of insulin may produce, is an internal stimulus if it initiates some response, such as an increase in stomach contractions, a depressed state, or the eating of candy. The glands of internal secretion pour out hormones which have stimulating effects on the organism. Chemical and electrical activities within a given nerve fibre may arouse activity in neighboring nerve fibres, or within muscles and glands. When they do this, they also are serving as internal stimuli.

Activities within the brain set off other specific brain activities. When you “think of something” and this influences the way you act, the sequence of events is as follows: The activities of the brain which are going on

while this thought is present serve to activate other nervous and muscular processes. These, in turn, arouse further reactions. Thus we can say that brain activities (or indeed any organic activities) may act as stimuli for subsequent response. Such events occur when, for example, you suddenly realize that you have lost your pocketbook, you think of the places you have been, and you return to look for it. The nature of thought in such cases is considered in Chapter 12.

### Instructional sets

Quite often in psychological research it is necessary to introduce a special kind of control which, while it involves variations in internal stimuli, is usually referred to as control of *attitude* or *set*. The subject in a reaction time experiment, for instance, may be told to respond when the light is red and not when it is green. These instructions produce an internal set which facilitates response to red and inhibits response to green. Such sets and their relationship to stimulation receive further consideration in subsequent discussions.

Sometimes it is necessary to control set in other ways. We may make the subject think that he is taking a drug, say a capsule of caffeine, whereas he is in reality taking a capsule of water.\* Or we may cause him to think that he is performing very poorly on a test, even though his performance is average. Or we may induce him to think that one type of response is being studied while we are in reality studying another. Of course the subject is eventually told that, for experimental purposes, it had been necessary to misinform him.

The reader may wonder why it is necessary to "fool" the subject. This sort of control is sometimes necessary because the subject's response can be greatly influenced by internal sets which he may himself assume. We try to obviate these by providing a uniform set as part of the experimental procedure.

\* A doctor, just to please the patient who really needs no medicine, may give him a tablet or pill with no medicinal properties. This is called a *placebo*. In the experiment here described, the capsule with water would be similarly designated.

*Response.* A response, as we have already suggested, is any action brought about by stimulation, either external or internal. Many responses are clearly observable without the use of instruments. These are referred to as *gross* behavior, or as *explicit* or *overt*. They may also be referred to as verbal or non-verbal.

Some responses are internal. These are, so to speak "covered," hence we refer to them as *covert*. They are also said to be *implicit*. Physiological responses like heart palpitation and changes in blood pressure and body temperature, although measurable with instruments, are regarded as implicit. Activities within the nervous system are also implicit. These and other responses give rise to physiological activities that are related to our personal thought processes and feelings which we likewise refer to as implicit—although they may, in a sense, be made explicit through verbal reports from the subject.

Now that the meaning of stimulation and response is clear, we are ready for a more detailed study of psychological experiments.

## PSYCHOLOGICAL EXPERIMENTS

The psychological investigator, in arranging his experiments, must take cognizance of: (1) the type of organism being studied, (2) what the organism has already learned, (3) the present condition of the organism, (4) the stimuli operative in the experimental situation, and (5) the responses to be measured.

The type of organism to be investigated (whether animal or human, child or adult, male or female) is decided before the experiment begins.

What the subject has already learned (skills or information relevant to the experiment) is also considered before the experiment begins. For certain purposes it is necessary to choose subjects who have none of the specific skills and none of the information utilized in the experiment.

The present condition of the organism (hungry, fatigued) is something which the experimenter must either hold constant or vary as the needs of his experiment demand.

Stimuli, we have seen, must also be varied or held constant. Usually the stimuli to be controlled are external, but the investigator may have to control internal stimuli as well.

Finally, as indicated above, the experimenter must decide which responses he is going to measure. The nature of the questions with which his research began will of course influence this decision. If he is interested in speed of reaction, he measures reaction time, using some sort of chronoscope to do so. He may, however, want to know the emotional reactions produced by certain situations. In this case he studies a number of responses: verbal reports of his subjects, their facial expressions, their heart activity, their breathing, and so on. If the learning process is investigated, the responses studied will be correct reactions, errors, or any others representing the efficiency of performance.

The stimuli or organic conditions manipulated by an experimenter are referred to as *independent variables*. The measured responses of the subject, however, are said to be the *dependent variables*.

#### The independent variable

This is so designated because it is the variable manipulated by the experimenter in accordance with the nature of the question which his experiment is to answer. Except where special statistical procedures are used, there is only one independent variable in a given experimental observation. The reason why this must be so is perhaps obvious. Suppose that the experimenter investigating obstacle avoidance in the blind had stopped up a subject's ears and also covered his head and shoulders. Suppose, moreover, that the subject now collided with obstacles placed before him. How could the investigator know which of the variables produced this change in behavior? Of course he could not know. Actually, one factor was studied at a time. In this way, the variation which interfered with obstacle avoidance was isolated.

Not every independent variable involves manipulation of stimuli as in the experiment described. The independent variable may be the maturity, or sex, or physiological condition of the organism. This is true if one is to compare the learning, say, of children and adults. Here the stimuli (learning tests) are constant. What varies is *age*. Likewise, if one is studying sex differences in some performance, *sex* is the independent variable. If

some organic condition, say hunger, is under consideration, then the *degree to which this condition is present* will be the independent variable.

Even when an experiment is designed statistically so that more than one factor may be varied at the same time, statistical analysis eventually isolates the influence of each factor. With statistical procedures, also, the interdependent action of two or more variables, with the relative contribution of single variables may be studied. But the details of statistical experimental design are too complicated for discussion outside of books on advanced statistics.

#### Dependent variables

In addition to varying certain stimuli or organic conditions (while holding other stimuli and organic conditions constant) the experimenter observes and measures his subjects' responses. These are said to be *dependent variables* because they depend upon (or possibly depend upon) the factor whose isolated influence is under investigation. Sometimes the investigator studies gross behavior, like facial expressions or maze running; sometimes he focuses upon physiological processes, like heart action or blood pressure; sometimes he confines his attention to verbal reports which reveal feelings or perceptions; and sometimes he is interested in all such dependent variables. This may well be true, for example, in studies of emotion where gross behavior, physiological changes, and feelings are aspects of the overall pattern of response.

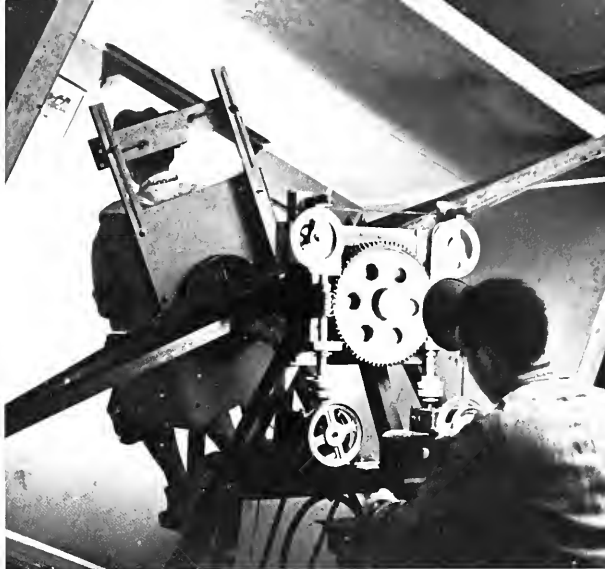
#### Control and experimental conditions

A *control* condition is the normal or natural one. In the experiment on avoidance of obstacles by the blind, for example, the control situation is the one in which avoidance normally occurs. With this condition, stimulation is not interfered with.

An *experimental* condition is one involving the introduction of some modification designed to answer the experimenter's question. In the experiment just mentioned, one question was: "Is hearing used in avoidance of obstacles?" The experimental condition, accordingly, was that in which the subject's ears were blocked. Performance under this condition was then



**2.6 A Movable Environment.** The room and the chair can be tilted to any desired position. In this test, the room has been tilted, and the subject has been asked to adjust her chair so that she is upright. Visual cues make her think that she has changed to the upright position even though, as indicated by the arrow, she has not done so. When blindfolded, however, she relies on the pull of gravity without being confounded by the visual environment. Then, as the arrow shows, she adjusts her chair to the upright position almost exactly. (From Witkin, H. A., "The Perception of the Upright," *Scientific American*, February, 1959, pp. 50, 52, 53. Photos by David Linton.)





**2.7 An Example of a Controlled Environment.** This olfactorium, as it is called, was built at Cornell University to produce a completely odor-free environment which, for the sense of smell, is comparable with a darkroom for the study of visual stimulation and a soundproof room for the study of hearing. After bathing, the subject enters the anteroom of the olfactorium, puts on an odorless plastic envelope, and enters the stimulus chamber, which has automatic air-purification and control apparatus. From the outside, the experimenter may stimulate his subject by introducing the odors to which sensitivity is to be determined. (From the *American Journal of Psychology*, July 1950, p. 434.)

compared with that under the control condition. If no differences in performance were observed, one would have to conclude that hearing was *not* a factor. Since the performances under the control and experimental conditions differed so decidedly, there was no question but that hearing played a very important role in this behavior.

Experimental conditions in psychology are frequently much more elaborate than in our example. Sometimes, as illustrated in Figures 2.6 (p. 41), 2.7, and 2.8, the individual's environment is altered drastically to study the effect of this, or some aspect of it, upon his behavior. In such instances, highly complicated apparatus is required to produce the desired conditions.

#### Counterbalancing

In many psychological experiments it is necessary to use a sequence of experimental and control conditions which will nullify pro-

gressive effects, like those of practice and fatigue. Take, for example, an experiment in which the investigator wants to discover the effect of a particular *set* on speed of reaction. One set, let us say, is *attend only to the stimulus*. The reaction key is pressed as quickly as possible when the stimulus appears. The other set requires no special attention to the stimulus: the subject is told to *attend only to the act of pressing the response key*. The investigator of course uses the same stimulus with both the stimulus and response sets. He will also use the same chronoscope, the same type of reaction key, and the same general situation. That is to say, he will *hold these factors constant*. But suppose that the experimenter gave a number of tests (perhaps 100) with the *stimulus set*, followed by 100 with the *response set*. If there should be a progressive adaptation to the experimental situation (a learning to adjust to it), he would be stacking the cards in favor of better performance under the response set. An improve-

ment in the second 100 tests over the first might then be due to learning and not to the difference in set. Suppose on the other hand, that the subject becomes fatigued during the experiment. Then such a procedure as we have described would be biased in favor of the stimulus set. That is, quite apart from the influence of set, our subject might do better on the first 100 tests because he is less tired than during the last 100 tests. It is quite obvious, therefore, that experiments of this nature require a sequence of tests which equate, rule out the effects of, or, in a word, *control* such factors as learning and fatigue. Such control may be achieved by using a counterbalanced order such as *stimulus set* (50 tests), *response set* (100 tests), and *stimulus set* (50 tests). This is often referred to as an *a b a* sequence. Measurements obtained in the *a* series are added and averaged; likewise, those obtained in the *b* series. One can readily see that use of such a counterbalanced sequence throws the effect of progressive factors like learning and fatigue equally upon each of the two variables (response set and stimulus set). The outcome, in this instance, is then influenced only by the difference in set.

#### Controlling set

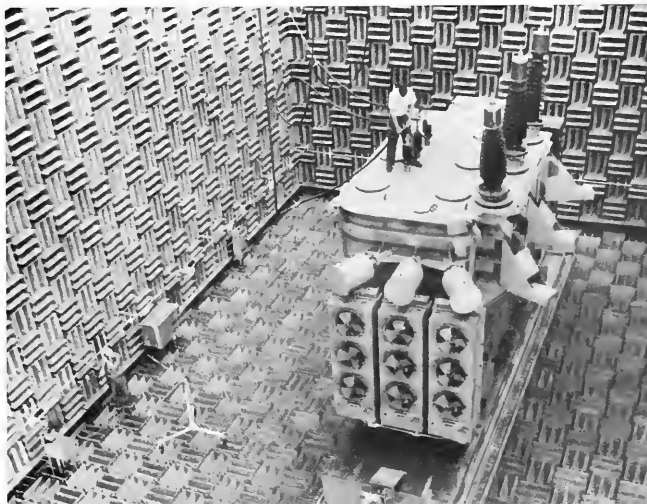
We mentioned earlier, with respect to control of internal stimuli, that the subject's set must often be manipulated by the investigator

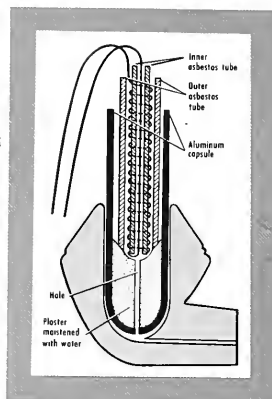
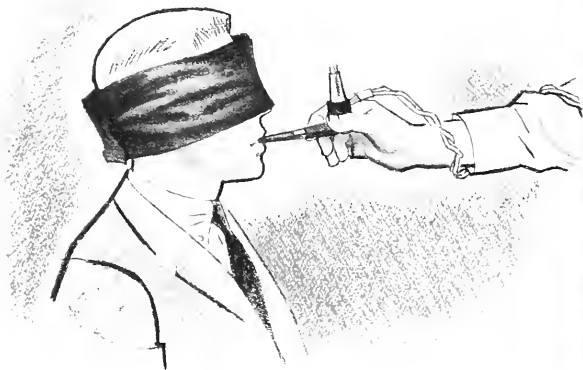
in such a way as to mislead the subject. The need for such control is notable in research on the psychological effects of drugs.

*A drug experiment.* Several years ago a well-known investigator in the field of pharmaceutical chemistry gave a lecture before a scientific gathering in which he described the increased psychological efficiency produced by a highly publicized drug. His experiment was, in essence, as follows: Students were injected on some days with the drug. This was the experimental condition. On other days there was no injection. This, of course, was the control condition. On the experimental and control days, which were alternated in accordance with a more or less randomized sequence, several tests were administered. The average performance on such tests was decidedly higher for experimental than for control conditions, hence the alleged potency of the drug in increasing efficiency. But it was quite obvious to many scientists in the audience that the investigator had failed to control a very important factor — the attitude of his subjects. The apparently beneficial results of the drug could have resulted from (1) its suggested potency, (2) the expectation of beneficial effects, and (3) increased effort while taking the tests, because of such suggestion and expectancy. In view of our earlier discussion, it is obvious that the experimenter should have counteracted such possible attitudes by using a placebo on control days. That is to say, he should have

## 2.8 An Anechoic Chamber.

This provides an environment in which echoes are negligible. Thus auditory phenomena can be studied under conditions almost completely under the control of the experimenter. In this instance the noise characteristics of a General Electric transmitter are being studied. (Courtesy Balt, Beranck, Newman, Inc.)





**2.9 An Experiment on Smoking.** Here one sees certain features of the pipe and how they provided the necessary controls. Warm moist air was drawn through the hole as described in the text. (After Hull.)

given an injection every day; of the drug on experimental days and of sterile water on control days. This should have been done in such a way as to prevent the subjects from knowing when they were getting the drug and when they were not. Under these conditions, providing that other necessary controls were also involved, the effect of the drug, if any, would have been revealed.

*An experiment on smoking.* The ingenuity which psychologists must sometimes use to control set is illustrated by an experiment designed to discover the effect of tobacco smoke on a variety of psychological reactions.<sup>6</sup>

If the subject should feel that smoking is harmful, he might put forth less than normal effort, even without realizing that he is doing so. Another subject might want to show that smoking is not harmful, hence increase his effort, with or without being aware of the fact. It is clearly necessary, then, to prevent the subject from knowing whether or not he is smoking. This might at first appear impossible. Nonetheless it was accomplished, using the pipe illustrated in Figure 2.9.

The experimental pipe and the control one were identical in all respects except that the former contained tobacco and the latter did

not. While the control pipe was being used, the experimenter himself smoked, so that there was an odor of tobacco smoke in the room. When the tobaccoless pipe was used, the subject was drawing warm air through it. Thus, during control sessions the subject puffed at warm air and smelled the tobacco smoke in the room. The illusion that tobacco smoking occurred in both the control and the experimental sessions was also aided by the following controls: The subjects were always blindfolded. The experimenter made as much noise (scratching matches, knocking the pipe, etc.) in tobaccoless as in tobacco sessions. The pipe was placed in the subject's mouth, held there while he puffed at it, and withdrawn by the experimenter. The subject was required to blow out the smoke without inhaling. He was told not to swallow his saliva, but to spit it out in a receptacle provided for this purpose. Finally, when the subject completed a session and the blindfold was removed, he always saw the burnt-out ash in the pipe that, presumably, he had been smoking. Reports from subjects, after the experiment had been completed, proved that they were never suspicious of the fact that they had sometimes been puffing on warm

tobaccoless air. One subject actually went through the motions of blowing smoke rings while using the control pipe.

The outcome of this experiment is of incidental concern to us here, since what we are illustrating is experimental methodology. Nevertheless, it is interesting to note that while smoking did not significantly influence most of the psychological processes studied, it did produce a significant decrease in muscular steadiness.

### Experimental and control groups

In psychological experimentation it is sometimes necessary to use two or more groups, one subjected to the control and others to the experimental conditions. This is true whenever responses to different conditions, which cannot be used with the same subject, are being compared.

*Co-twin control.* Suppose, for example, that we want to know the influence of early training on some aspect of child behavior, like urinating in the toilet. Some children must be given the special training, while others are left to their own resources. This means, of course, that two groups are needed. Children given special training constitute the *experimental* group; those given no special training, the *control* group. It is a well-known fact, though, that some children naturally develop faster than others — that they *mature* faster. The child's ability to withhold urination until on the toilet might develop anyhow, apart from training. Even with training, this habit might develop faster in some children than in others. It is apparent, therefore, that our experimental and control groups must be equivalent with respect to the maturation or growth factor. The most satisfactory way to hold this factor constant is to use *identical* twins, with one of each pair going to the experimental and the other to the control group. Psychologists call this the method of *co-twin control*. Its effectiveness comes from the fact that identical twins have the same heredity and that maturation is largely under the control of hereditary factors. Hence, apart from the experimental condition, identical twins develop at the same rate. With this and other necessary controls accomplished, the relative effects of toilet training and nat-

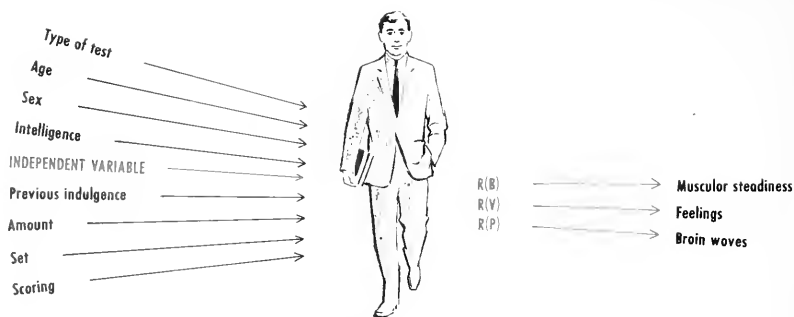
ural growth can be ascertained. An experiment of this nature revealed that toilet training before a certain level of maturity has been achieved is useless. Until attainment of this level, which differs from one child to another, the experimental children have no better toilet performance than their twin controls.<sup>7</sup>

*Split litters.* In experiments with animals, hereditary aspects are often controlled, at least to some extent, by what is called the *split-litter* technique. Assume that we need three equivalent groups, one control and two others, each of the latter receiving, let us say, a different kind of training. The aim here would be to compare the effectiveness of the different kinds of training. Since rats often have litters of a dozen or so, four from a particular litter may go to the control group, four from the same litter may go to the first experimental group, and the remaining four of this litter may go to the second experimental group.

*Other equivalent groups.* In many experiments with human subjects where equivalent groups are needed, but where one does not have access to identical twins, such groups may be obtained in a variety of ways. In learning experiments, for example, one may give all potential subjects the same initial learning test and, on the basis of their scores, derive two or more groups with the same average learning score. Similarly, groups may be equated on the basis of age, intelligence, or other factors considered important for the particular experiment.

Sometimes equivalent groups are arranged by assigning subjects to particular groups on a random basis. This method is useful when the groups are to be large, the reason being that, in a large group, the effects of individual differences tend to cancel each other. But such assignment must be made with due regard to statistical and other considerations which cannot be dealt with in an elementary discussion.

*Matched groups.* Investigators often use the procedure of matching groups in all important respects. Suppose, for example, that one wants to know the effect of a particular form of psychotherapy on schizophrenic patients. It is not sufficient to take any group of schizophrenics and give the therapy, for some recover spontaneously and the recovery



**2.10 Schema of a Typical Psychological Experiment.** The independent variable is that which the experimenter manipulates (e.g., adding or subtracting it from the situation, or varying its amount). Practice, alcohol, hunger, and visual stimulation are examples of such variables. The block lines at the left represent constant factors. Thus, in an experiment to assess the effects on reasoning of a certain amount of alcohol, such factors as the age, sex, intelligence, and previous indulgence of the subjects would be held constant. Likewise, the amount of alcohol, the test of reasoning, the time since drinking that it is administered, and methods of scoring results would need to be the same for all subjects. Still another of many factors to be held constant would be the attitude or set of the subjects. The alcohol should somehow be disguised so that subjects did not know when they were getting it and when a non-alcoholic beverage was being drunk. The  $R$ 's refer to dependent variables, in this case, psychological changes produced by alcohol. They are represented at the right in blue.  $R(B)$  refers to gross behavior variables (like muscular steadiness, speed of reaction, motor coordination, and performance on learning and reasoning tasks).  $R(P)$  represents internal physiological changes such as heart rate, secretion of adrenalin, and brain waves. By  $R(V)$  we refer to what the subject says in describing his experiences such as feelings of clumsiness, nervousness, or exhilaration.

rate may depend upon (vary with) such things as sex, age, education, and the type and duration of the illness. It is customary, therefore, to arrange two equivalent groups by matching subjects. A female schizophrenic of a certain age, educational level, and duration of the illness will be matched with another in these, and perhaps other, respects. Then one of the pair will be assigned to the experimental (therapy) and the other to the control (no therapy) group. A male schizophrenic might be matched, similarly, with another male schizophrenic and each assigned to a different group. After two sufficiently large groups, equivalent with respect to sex, and matched subject with subject are obtained, one group is given therapy and the other not. Should there be a significantly greater num-

ber of recoveries or improvements in the therapy group, this would then be attributed to the therapy. It could not be attributed to spontaneous recovery or to other nonexperimental conditions.

Much more could be said about the sorts of control necessary in psychological research but the foregoing is sufficient to reveal some of the problems involved. Many features of psychological experimentation are presented schematically in Figure 2.10.

## STATISTICAL PROCEDURES

Statistics is an application of mathematics which facilitates the design of experiments and the analysis and evaluation of results. In several places we have referred to the use of

statistics in psychological research. In discussing the origins of scientific psychology, we told how statistical analysis became an important aid in the study of individual differences. More will be said about this when current work on individual differences in intelligence, aptitude, and personality is surveyed.

### Statistics in experimental research

Attention has already been called to the use of statistical procedures in designing experiments. One may recall, for example, our reference to the use of statistics in cases where more than one independent variable is to be used and in selecting groups on a truly random basis.

After an experiment has been done, statistical analysis of the results is often necessary. This is almost certainly true when many measurements have been obtained under experimental and control conditions, whether on the same subject or on groups of subjects. It is then necessary to obtain a statistical measure which represents the results obtained under each condition. There are several possible measures, but the one most frequently used is the average, or *mean*. This is obtained by adding the various measurements and dividing the total by the number of measurements involved.

### The reliability of differences

When the means have been calculated for, respectively, the experimental and control conditions, the next thing to ascertain is whether a difference exists. There may be no difference, in which case the experimental condition has obviously had no influence. If there is a difference, it may be in favor of either the experimental or the control condition. The question which then arises, and one which also must be answered by statistical analysis, is whether this difference is a reliable one. One must ask, "What is the probability that a repetition of the experiment would reveal no difference?" In deciding such issues the investigator may get into some rather involved statistics which need not concern a beginner in psychology. However, the statistical appendix (p. 537) contains some introductory information on how the reliability of differences may be calculated.

Appropriate statistical analysis may indicate that a difference in the direction found would occur by chance less than once in 1,000. If this were so, the experimenter would be correct 999 times in 1,000 in assuming that he had obtained a real (not merely a chance) difference between responses in the control and in the experimental conditions. This would of course indicate a very high degree of reliability. Usually a difference is regarded as statistically *insignificant* unless the level of confidence is at least 5 per cent, i.e., unless the chances are at least 95 in 100 that it has been experimentally produced. To the student this may appear to be an overly cautious attitude, but scientists must be reasonably sure that findings on which they base their conclusions are reliable.

### R-R relationships

In the last analysis, all psychological research deals with  $S \rightarrow O \rightarrow R$  (stimulus-organism-response) relationships. As indicated in our earlier discussion, it focuses on responses elicited by internal and external stimuli. Quite often, however, an investigator is interested not so much in what stimuli produce particular responses but in *how one response is related to another response*. In one study with adolescent boys, for example, the investigator was interested in discovering a possible relationship between a boy's physical strength (as measured by a test of strength) and social prestige (as represented by measures of social acceptance among other boys). In studying responses indicative of strength on the one hand and those which make for acceptance by the peer group on the other, this investigator was looking for a possible response-response, or R-R, relationship. He did, in fact, obtain results indicative of such a relationship.<sup>5</sup>

The discovery of R-R relationships calls for not only measurement of the respective responses but also a detailed statistical analysis of such measurements. The statistical procedure is that of *correlation* and the outcome is some index of the degree of relationship between the measurements. One such index is called the *coefficient of correlation*. How some such indices are calculated is demonstrated in the statistical appendix.

When experiments and statistical calcula-

tions have revealed that there is a high correlation between, let us say, response X and response Y, we can predict X from Y or Y from X. We make such predictions whenever we select students or workers on the basis of standardized tests. In Chapter 5, some previously mentioned data are presented which show that, of those candidates for pilot training who made above a certain score on a battery of aptitude tests, approximately 95 per cent became pilots. The data also show that, of those who made below a certain score, only 20 per cent became pilots. On

the basis of such R-R relationships, those charged with selection of pilot trainees during the second world war could, in terms of test responses alone, predict the effectiveness of responses in the training situation. They did, in fact, select a large group with the knowledge that a predictable percentage would pass the course.<sup>9</sup> This illustrates one of many practical outcomes of the investigation of R-R relationships. Other R-R relationships are revealed in later discussions dealing with individual differences in intelligence, aptitude, and personality.

## Summary

The ultimate aim of psychology is to discover the stimulating and organic conditions of which psychological processes are functions; that is, the  $S \rightarrow O \rightarrow R$  (stimulus, organism, response) functions. Investigation begins with the asking of relevant questions. These may be theoretical, or practical, or both. An objective and systematic procedure calculated to force an answer to the questions is arranged. Sometimes the investigator's interest is in how a particular psychological process evolved in the animal series (phylogenetic approach) or how it develops from earlier to later age levels in the same species (ontogenetic approach). Both of these approaches comprise what is known generally as developmental psychology. Comparison of one species with another, whether or not developmental trends are sought, is comparative psychology. When questions have reference to the problems of an individual—how he got that way and what to do about it—we have an example of the clinical approach. It is here that case histories become important.

Sometimes we want to observe behavior which either could not be produced in the laboratory or which would be distorted if produced there (interactions in free ranging animals, in crowds, and in children at play). Naturalistic methods are then used, perhaps including movies and tape recordings for later analysis. Quite often, however, experimental

procedures are introduced into a naturalistic setting to discover facts not otherwise available (avoidance of obstacles by the blind, reproductive behavior in the stickleback). Because it provides maximum control over the variables involved in behavior, experimental procedure is more widely used than any other. Its major aspects involve control of stimuli and the organism and measurement of responses. The stimuli to be controlled may be external (light, sound, odor) or internal (blood sugar, drugs). Among the internal factors are instructional sets (attitudes, as in the drug and smoking experiments). The responses measured may be gross overt behavior (motor coordination, errors of adjustment), physiological (blood pressure, pulse rate), or verbal (descriptions of feelings or perceptions).

In a typical experiment the investigator, either directly or indirectly (through statistical procedures), isolates the influence of one factor at a time, keeping all others constant. This is what experimental control means. The isolated factor (a stimulating or organic condition varied by the investigator) is referred to as the independent variable. The measured responses subsequent to the introduction of this variable are the dependent variables. What the investigator seeks is to discover whether or not, and if so, to what extent, such responses depend upon the independent variable.



Special note has been made of procedures for holding certain factors constant while another is varied. Among these are counterbalancing, inducing appropriate sets, and obtaining comparable control and experimental groups through co-twin control, split litters, and other matching procedures.

Statistical procedures play an important part in designing experiments, in comparing the results obtained under experimental and controlled conditions, in determining the reliability of such differences, and in discovering R-R relationships, as between test performance and performance in an actual life situation.

(References and notes for this chapter are on page 543 of the Appendix.)

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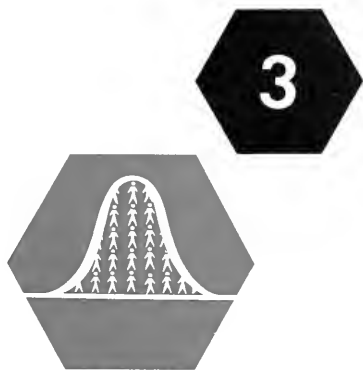
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# Individual Differences



The scientific study of individual differences • Statistical analysis of individual differences • The distribution of individual differences • The status of the individual • Correlation • How individual differences originate • Heredity • Environment • Heredity and environment • Experiments with heredity and environment — heredity constant • Experiments with heredity and environment — environment constant • Summary

One of the most obvious things about human beings is that they differ. They differ in size, shape, appearance, speed of reaction and innumerable other aspects of behavior. But individual differences are by no means confined to the human level. We find them in all organisms. They are most obvious in human beings because we know these so well and observe them so closely.

Although all ants, or fish, or rats look alike to the casual observer, any student of animal behavior soon observes that his ant, fish or rat subjects differ markedly from each other, and in behavior as well as structure. Some are active and others sluggish, some learn quickly and others slowly, some remember well and others forget. Indeed there are gradations of activity level, learning ability and other characteristics, sometimes over a wide range. The farmer is also aware of differences among his sheep, his cows, and his hens — although he is likely to be impressed especially with differences of practical interest to him, such as how these animals differ in wool clip, milk production or egg output.

Among human beings the most obvious differences are in such bodily characteristics as height, weight, color, and facial appearance. These impress the observer almost immediately. Differences in behavior are much less evident. We may observe that a

person's handshake, his accent, or his general conduct is different from that of others we know, but it is not until we have had closer acquaintance with him that we appreciate in how many ways his behavior marks him off from other people. Even then, many differentiating features of behavior escape us. We observe only what is on the surface — and perhaps then only what the individual wants us to observe. Much that is hidden, whether intentionally or otherwise, becomes evident only if we can study the individual as psychologists do, using tests and measurements designed to reveal psychological differences. This is especially true when differences in ability to perform certain kinds of work, scholastic or otherwise, are at issue. Many differentiating aspects of his own behavior, including his abilities, may not be known to the individual himself. Thus he may ask to be tested or observed so that he can learn for himself how much he is alike or different from others. He may, for example, want to know whether or not he is fitted for a particular line of work. On the other hand, the individual may be asked by a prospective employer to take various tests, the aim being to observe whether he has characteristics required in a particular job.

Differences in ability have been recognized since ancient times and it has been rather generally conceded that the ideal society would be one in which, among other things, each person contributed in accordance with his abilities. Only in recent times, however, have individual differences in ability received much attention from scientists. One may recall, in this connection, our earlier discussion of Cattell's pioneer work on individual differences in sensory, motor, and other abilities and Binet's development of mental tests designed for the proper grade placement of school children.

The First World War led to an upsurge of interest in the detection and utilization of individual differences — especially in intelligence. This was due to the need to select men, in terms of their level of intelligence, for officer training and various military specialties. Research on individual differences thereafter continued apace and reached another peak during the Second World War, when many specific abilities as well as intelligence were under investigation and especially those needed to fly aircraft and handle other complicated military equipment.

Rather obviously there are larger individual differences in some abilities than in others. Most of us can learn such relatively simple skills as driving a nail or cutting with scissors. In acquiring such skills, we do not differ much, one from the other. But when highly complex skills are called for, the difference between the least and the most skilled is very large. In fact the person with maximum skill may be many times as skillful as the one with minimum skill. Some skills are so complex that certain individuals are unable to achieve them even to a minimal degree. This is especially true in the case of skills requiring a high level of reasoning ability. The person skilled in atomic physics, for instance, has left all but a few of his fellows far behind. This being the case, it is not surprising that the United States and other countries are engaged in a vigorous search for those with talents needed in national defense. In this "talent search," psychological tests are playing an important role.

Although our discussion has emphasized the existence of individual differences in bodily characteristics and the less obvious differences in ability, there are other differences. Among these are differences in aspects of personality, in character, and in attitudes. As later discussions will show, these are also of great interest to psychologists.

## THE SCIENTIFIC STUDY OF INDIVIDUAL DIFFERENCES

It is one thing to observe individual differences in a general way and quite another to study them scientifically. The latter requires measurement of individual characteristics, or *traits*.

### Measurement of individual characteristics

It has been said<sup>1</sup> that "Whatever exists at all exists in some amount." This is as true of psychological characteristics, including talent, as it is of the various physical aspects of our world.

The first task of the student of individual differences is to discover how much each individual has of whatever is being investigated. Only after this has been ascertained is it possible to discover the difference which exists between one individual and others. Only after this, moreover, can the study of individual differences be put to practical use.

It is not sufficient for scientific purposes to use general terms. Statements such that someone has "a lot of talent," "not much talent," or "a great deal of personality" may be correct, but a scientist must know more precisely how much each trait is present. He needs to quantify, which means that he needs to be able to use numbers rather than adjectives to represent what he observes.

**Physical units.** Measurements of traits like height, weight, chest expansion, the shape of the skull, and strength of grip are made in physical units. Take strength of grip as measured by a dynamometer (Figure 3.1). The individual measurement is in units of weight; in this case, in kilograms. Theoretically the individual could score zero (no measurable grip) or anything between this and 100 (the strongest conceivable grip). Note that there is not only a zero point, but that all units of measurement are equal. The unit between 45 and 46, for example, is equivalent to that between 10 and 11. In view of the zero anchorage and the equivalent units along this scale, the person who registers 50 kilograms has twice the strength of the individual who, under comparable conditions, registers only 25. Because such scales allow us to say that one person has twice (or half) the amount of something



**3.1 A Hand Dynamometer.** The instrument is adjustable for hands of different size. Note that the scale is in kilograms and that it reads, in equal units, from zero to 100.

possessed by the other, they are often referred to as *ratio scales*.<sup>2</sup>

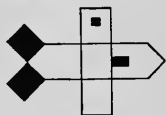
The existence of a zero point and equal units of measurement from zero to 100 makes it possible to measure the strength of different individuals in *absolute units*. Here the *amount* of a characteristic is measured in units of weight. Linear units, which also begin at zero and are equal one with another, are used to measure such things as how far or how high an individual jumps or how far he throws the discus. Units of time, also scaled in absolute units from zero up, give us such information as how fast an individual reacts, how long it takes him to solve a problem or how long he

This diagram is most likely to be found in a book on

- ( ) 1. botany
- ( ) 2. ethnology
- ( ) 3. lepidopterology
- ( ) 4. neurology



Which of these three-dimensional figures can be made by folding the pattern?



- ( ) 1.
- ( ) 2.
- ( ) 3.
- ( ) 4.



**3.2 Items from a Science Aptitude Test.** The complete test, which varies in content from year to year, is used in the Annual Science Talent Search to select those who will receive Westinghouse scholarships. In case they are needed, the answers appear on page 490 (Courtesy Science Service.)

persists at a task before giving up.

**Psychological units.** All of the above is fairly obvious, but calling it to mind provides a background for discussing psychological measurements in which physical units such as weight, length, or duration are not applicable. This is especially true with respect to traits like intelligence, aptitude or talent, character, and sociability. How can we specify the intelligence, scientific aptitude, or honesty of an individual? We certainly cannot do it in physical units, or in absolute units of any kind. Except theoretically, there is no such amount as zero intelligence, zero honesty, or zero scientific talent.<sup>3</sup> Nor is there a measurable upper limit to such characteristics. Moreover, at higher levels, it is increasingly difficult for one person to surpass another. At lower levels, it would be relatively easy for this to occur. In short, there is no known zero, there is no known upper limit, and increments in which individuals might be said to differ may vary along the scale. This does

not, however, leave us at an impasse as far as measurement is concerned. As will be clearer when the statistical analysis of individual differences is discussed later in this chapter, we use a relative rather than an absolute scale—and this works very well for our purposes. Instead of cardinal numbers, like the one, two, three . . . of physical scales, we use ordinal numbers; those which represent orders of magnitude, like first, second, third, and so on. Thus the scales with which we measure specific talents, aspects of character, and many other traits are *ordinal scales*.<sup>4</sup>

**Ordinal scales.** As an example of ordinal measurement let us consider the two items in Figure 3.2, which were taken from a test designed to measure scientific aptitude. Each individual is given many such items, which have been especially selected to tap various qualities which underlie scientific success. In our example we have one item which gives some indication of achievement in a special field—neurology. There are items like this from various fields of science. The person who already knows a lot about many scientific fields is one in whom the tester of scientific talent is of course interested. But our other item, representative of many in such tests, does not depend so much upon what the individual has already learned. Its solution calls for keen observation, for ability to handle spatial relations symbolically, and perhaps other qualities. This is a very inadequate sampling of aptitude tests, which are discussed more fully in Chapter 5. What is of particular interest to us now, however, is how such tests indicate the *amount* or *degree* of a person's aptitude, or whatever other trait is being investigated.

Tested with others under comparable conditions, the individual obtains a score based upon the number of items answered correctly within the time limit. This score in itself is interesting, but we need to know much more. We need to know how it compares with other scores. Where does it place this individual with respect to the others? Is the score average? Is it above or below average? More specifically, if the score is above or below average, how far is it above or below? We may consider the score in terms of rank. Is it in the top tenth, or even the top hundredth? Although there are more refined ways of in-

dicating the value of a score on such tests, it is clear that a test score in itself (unlike kilograms on the dynamometer) is largely meaningless. What counts is where it ranks within the distribution of other scores. We may say that, in such tests, the individual's performance is rated in terms of how much it differs from that of others.\*

Ordinal scales are not always tests, in the above sense. There are, for example, a number of social maturity scales with which individuals are rated for various social activities. Such scales are essentially checklists. A rater checks the items which apply to the individual and the score is the number of items checked. This score, like those mentioned above, is evaluated in terms of how the individual's rating compares with that of others of his own age. In some instances, as was pointed out in a previous discussion (p. 34), the rater indicates the degree to which a particular characteristic is present. Instead of saying that a child is or is not sociable, for instance, the observer rates him on a five-point scale: (1) plays by self, (2) merely looks on, (3) joins group but does not play, (4) plays in group but does not cooperate, (5) cooperates in joint enterprises. There is no question here of zero or maximum sociability. Nor is there any idea that the difference between 1 and 2 is equivalent to that between 4 and 5. The numbers are merely ordinal.

\* Theoretically, at least, a test can be designed so that its scores give equal increments. Thus the selection of items and their weighting can be such that the difference between a score of 50 and a score of 60, for example, is equal to the difference between the scores of 120 and 130. When a test is constructed so that its increments are equal in this way, it is referred to as an *interval scale*. It is then somewhat analogous to the scale of a thermometer, where zero must be arbitrarily set, but where the successive units are equal. A test of intelligence which yields smaller increments as maturity approaches is, of course, not an interval scale. The advantage of an interval scale, as compared with an ordinal one, is that results obtained with it lend themselves to statistical analyses which would not be justified in the case of the latter. For more about this, see S. S. Stevens in the reference already given, or on pp. 257-261 of Boring, Langfeld, and Weld's *Foundations of Psychology*. Wiley, 1948.

Many other individual traits are measured with ordinal scales and it is difficult to imagine how we could measure these in any but ordinal units.

### Reliability of measurements

The reliability of any set of measurements is judged in terms of consistency. Maximum consistency is found in measurements on a physical scale. Take measurements of height, for example. Such measurements are relatively free of error or other sources of variation from one measurement to another. Different persons may measure your height, each without reference to what the other has found, and they will get approximately the same number of feet and inches. Measuring to fractions of an inch will naturally lead to more variation, but this is insignificant for practical purposes. Where necessary, as in manufacture of precision equipment, measuring devices are refined to give almost any desired level of reliability. But we are concerned only with measurement of human beings, where such precision is needless.

Suppose that your height and that of many others has been measured to the nearest inch. How do we determine the reliability of the measuring instrument? We may do it in various ways, but one simple illustration will suffice. This illustration involves a statistical technique known as correlation. The reader may recall that correlation was referred to in an earlier discussion (p. 47). A more detailed consideration comes later in the present chapter.

We have, then, the height of each individual in the group. Now we repeat the measurements, perhaps having a different person make them. Then we place the first set of measurements in rank order: Rank 1 to the person who is, let us say, 6 feet 9 inches tall, Rank 2 to the person who is next in height, and so on, down to the person who is shortest. The second set of measurements is similarly ranked. If all individuals maintain the same rank in both sets of measurements, we will have a positive correlation, and a perfect one, between the two sets of measurements. Application of a correlation formula to our data will in this event yield a *reliability coefficient* of 1.00, the highest possible. However, some persons may have

straightened up more and others less during the second measurement. Moreover, the person measuring height may have misread the scale at times. Hence it is unlikely that the correlation will be 1.00, especially if the above variations cause some persons to change their rank in the second series.

When used properly, physical scales yield measurements which, like those in our example, are highly reliable. We can depend upon them both in measuring individuals and in measuring the magnitude of individual differences.

Many ordinal measurements also have high reliability, although not as high as that typically found for physical measurements.

The reliability of ordinal measurements may be determined in a manner comparable with that described for measurements of height. A test is administered to a large group and then, perhaps after a day or so, it is repeated. The sets of measurements obtained on these two occasions are then correlated. If each individual maintains a comparable rank on the first and second testing, even though his score changes somewhat, a reliability coefficient of 1.00 will result.

Another method is to devise equivalent forms of a test, give both forms to the same individuals, and then correlate the scores obtained with each form. If each individual had the same rank position on the two tests, we would again have a perfect correlation.

Our discussion of reliability has emphasized tests. Quite frequently, however, individuals are rated for a particular trait, as in the case of sociability, which has already been mentioned. The reliability of such measures is evaluated by correlating separate ratings. Two or more persons rate each individual independently. The separate ratings are then correlated. A perfect correlation would signify that individuals were given equivalent ratings by each observer.

In reality, perfect correlations are seldom, if ever, found for different administrations or equivalent forms of the same test, or for the ranks assigned to individuals by different raters. The highest reliability coefficient obtained with an intelligence test is .98. It is not uncommon to have reliabilities around .90. Personality tests, as one might expect, have much lower reliability than this. Never-

theless some have a sufficiently high reliability to justify their use in personality assessment. This will be evident when we get to Chapter 9.

Ratings vary a great deal in reliability, depending upon the characteristics of the raters and what is rated. For example: three raters observed social behavior in children well known to them and rated thirty traits, each on a five-point scale. The lowest correlation between one set of ratings and another was .62; the highest was .82.<sup>5</sup> In another investigation, where observers merely rated children in terms of how active they were, reliability coefficients ranged from .92 to .98.<sup>6</sup>

Before closing this discussion it should be recognized that reliability is dependent upon much more than the nature of a measuring device. Take the dynamometer, for example. Even though it measures in physical units on a ratio scale, it may yield results which are far from reliable. Each individual must be instructed about what he is to do. Different instructions will yield different results. Moreover, one individual may "give it all he has" while another squeezes in a disinterested manner. All such variations lower the dynamometer's reliability as a measuring device. The same is true for tests of any kind. It is for this reason that psychological tests are preceded by standardized instructions and are best administered by fully-trained experts. These guarantee, so far as possible, that each individual works at the test in a comparable manner. With respect to scoring, there are again standard instructions. If this were not so, the performance of different individuals might be evaluated in different ways rather than on a comparable basis.

## STATISTICAL ANALYSIS OF INDIVIDUAL DIFFERENCES

From our discussion so far it is apparent that the investigator of individual differences must know the degree to which each individual has the trait studied and that, in order to obtain such knowledge, he needs reliable measuring devices, whether these are physical instruments, tests, or rating scales. But after individual measurements have been obtained,



the investigator must analyze and interpret his data. This requires statistical procedures.

Since the days of Cattell, Binet, Galton, and other pioneers in the study of individual differences, some of whom introduced statistical procedures in the life sciences, there has been a great expansion in the use of these techniques. Indeed statistical analysis has become highly specialized—so much so that investigators normally achieve competence only after years of study, usually at the graduate level. In an introductory course, therefore, one need not expect to attain anything beyond an understanding of a few basic statistical concepts.

It was necessary to introduce some statistical ideas into the discussions of scientific method and psychological measurement. In Chapter 2 we mentioned use of the *mean* (or average) to represent the central tendency of a group and also to compare groups. In that chapter we also pointed out that it is necessary to determine the reliability of differences between groups, and that this requires statistical analysis. Our discussion of R—R (response-response) laws in psychology introduced another statistical concept, that of *correlation*. This concept was used in the present chapter to show how the reliability of measurements may be discovered.

Now we turn more directly to the statistical analysis of differences between individual human beings and how these differences are interrelated. The discussion remains on an elementary level and deals with statistical concepts largely in verbal and graphic terms. However, the student who would prefer to delve a little more deeply and to work through some elementary statistical problems will find what he needs in the Statistical Appendix (pp. 537–542). If he wishes to go still further, the references cited there should prove helpful.

## THE DISTRIBUTION OF INDIVIDUAL DIFFERENCES

How do individuals differ with respect to a particular trait such as strength, speed of reaction, or intelligence? Can we divide them into the strong or weak, fast or slow, intelligent or unintelligent? Obviously we cannot. There are gradations from one extreme to the other and no application of statistical pro-

cedures is required to convince us of this point. But how are the observed variations distributed? That is a question which cannot be answered so easily.

### The frequency distribution

We begin our analysis by making what is called a *frequency distribution*. The procedure is quite simple. Let us tabulate, for example, the scores made by 100 students on a test of memory span. Each score is the longest list of simple words (like tree, box, ice, etc.) which the individual recalled in correct order after hearing them once. Here the scores are arranged haphazardly as we might have recorded them.

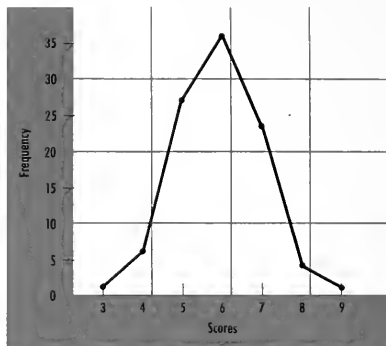
```
4 5 5 5 4 6 6 5 7 6 5 5 5 7 6 5 4 5 4 5
6 5 6 3 7 6 7 6 6 8 7 6 7 6 7 7 6 6 6 6
7 8 6 7 5 5 7 6 6 5 6 7 6 5 7 5 6 7 6 4
8 6 6 5 7 6 5 7 7 8 5 6 5 6 5 7 7 6 6 7
7 6 7 7 6 6 6 5 4 6 5 6 5 5 5 5 7 6 9 5
```

Observe that the lowest score is 3 and the highest 9. These and the scores between them are next arranged in a vertical column as illustrated in Figure 3.3. At the side of each score a tally has been placed to represent each occurrence of this score. Adding tallies gives the *frequency* of each score. For example, a memory span of 6 words was attained by 36 of the students. Its frequency is therefore 36.

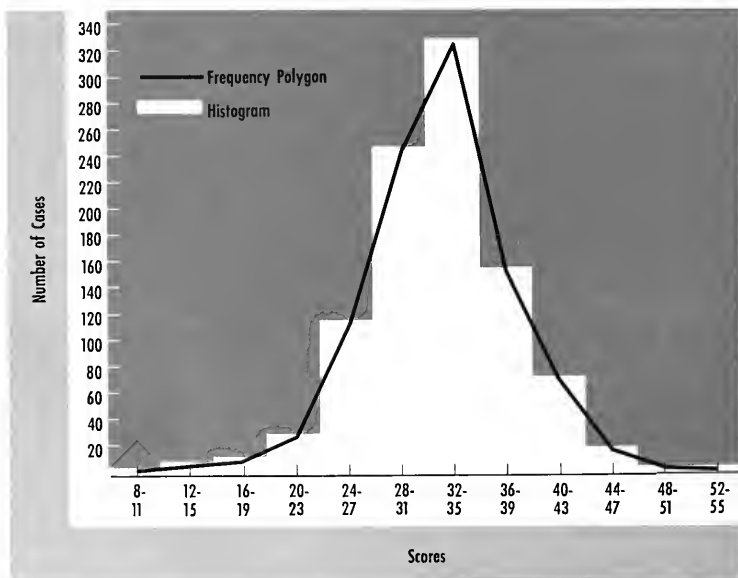
After getting the frequency of each score, we may represent the distribution graphically, also as in Figure 3.3. Distances to represent scores are laid out along the horizontal axis, known technically as the *abscissa*. Frequencies are represented on the vertical axis, or *ordinate*. Since there are 100 subjects in this particular sample, our ordinate represents not only the number making each score, but also the percentage. After marking above each score the height necessary to represent its frequency, we connect the points with straight lines, as illustrated. The result is a *frequency polygon*.

When there are many cases and scores cover a wide range one may group the latter into *class intervals*. Thus, if scores range from 8 to 55, we perhaps gather them into intervals as follows: 8–11, 12–15, 16–19, and so on until we get to 52–55. In making the frequency distribution we then obtain the frequency of

Score	Tallies	Frequency
3		1
4		6
5		28
6		36
7		24
8		4
9		1
N = 100		



**3.3 A Frequency Distribution and Polygon.** In all such curves, scores are represented as distances along the abscissa. The height of the curves (ordinate) above each score indicates the number of individuals making that score — that is, the score's frequency. As indicated in the text, the scores in this example are for memory span.



**3.4 A Frequency Polygon and a Histogram.** This shows how scores may be represented by group intervals and how either a polygon or a histogram may be used to indicate the characteristics of the distribution. (From Anastasi, A., *Differential Psychology* (3rd Ed.). Macmillan, 1958, p. 25. Used by permission of The Macmillan Company.)

each interval rather than the frequency of individual scores. Likewise, when a frequency polygon is drawn, the class intervals rather than individual scores are placed along the abscissa. The ordinates are then class-interval frequencies. A frequency polygon derived in this way from the scores of 1000 college students on a code-learning test is shown in Figure 3.4. Superimposed on the same graph is a *histogram*. Here the width of the column represents the class interval; its height, the frequency of that interval.

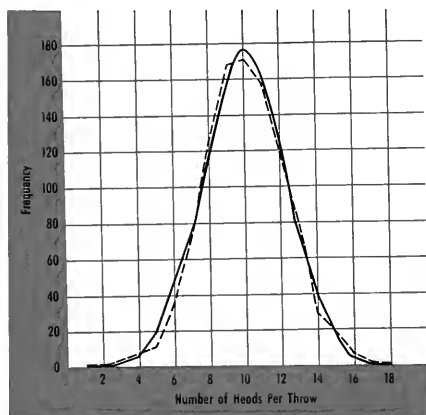
Sometimes a *bar graph* is used to represent a frequency distribution. This is like a histogram except that the columns, instead of being joined, are separated. The tallies of Figure 3.3, if turned with the scores at their base, constitute a simple bar graph. We can also use bar graphs to represent grossly discontinuous data, which should not be represented by polygons or histograms. For example: in

representing how many individuals pass and how many fail; how many vote Republican, Democrat, or Socialist; or how many receive each rating on some such device as the sociability scale already referred to (p. 34), where there are five abrupt steps with no measurable gradations between them.

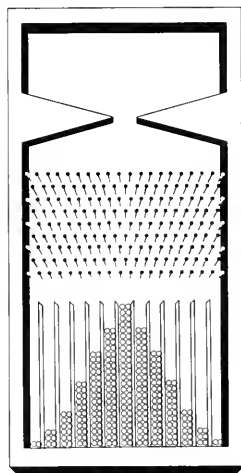
### The normal probability curve

When there are many unselected cases as in our code-learning example, a frequency polygon often approaches the shape of a normal probability curve. The characteristics of such a curve are produced by so many unobserved factors that it is said to result from chance. Sir Francis Galton, referred to earlier as a pioneer in the scientific study of individual differences, made a pinball machine to demonstrate how many unknown factors, acting conjointly, produce a probability distribution. His

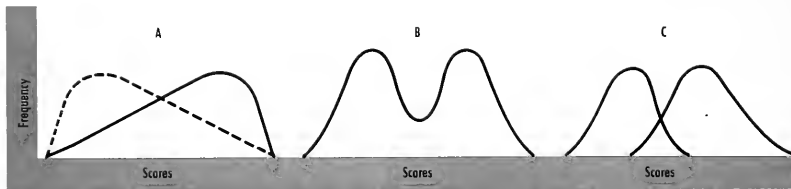
**3.5 Normal Probability.** A If everything operated in accordance with chance, tossing 20 pennies (rattling them up in a box and tossing them out on a table) 1000 times would yield the normal probability curve shown in solid print. The number of heads from 0 to 20 appears on the abscissa, and the number of throws in which each number of heads appeared is represented on the ordinate. The curve which appears in broken print is the result of an actual experiment. Instead of the expected average of 10 heads, the average was actually 9.98. The mode is, of course, 10 in both curves. B Galton's device to demonstrate a probability distribution. Shot is released from above, pieces of shot hit the nails and each other, and finally arrange themselves in the grooves below. (Courtesy Dr. E. O. Dodson and General Biological Supply House. Other details of this device appear in the February 1958 issue of *Turtox News*.)



A



B



**3.6 Variations from a Normal Distribution.** In **A** there are two curves, each skewed in a different direction, which means that there are more cases toward one end of the distribution than in the center. **B** illustrates what we mean by a *bimodal* curve. Here there are two scores of relatively high frequency rather than only one as in a normal curve. A curve like this suggests that two groups, or types of individuals, are represented in the distribution, as shown in **C**.

device is illustrated in Figure 3.5 (B). Beside this figure is a normal probability curve (A) obtained by students who tossed twenty pennies 1000 times and recorded the number of heads in each throw. Superimposed upon this curve is a mathematically derived probability curve. If the pennies had been tossed 10,000 times, the two curves would almost have coincided.

Observe that scores pile up in the center and that the most frequent score, referred to by statisticians as the *mode*, is represented on the abscissa as in the exact center of the normal distribution. When the population tested is very large, most psychological measurements, and such biological factors as height and weight, are distributed in approximate accordance with normal probability. The "chance" factors here are, as we shall see, related to differences in heredity and environment.

#### Variations from the normal curve

Divergences from the normal distribution curve provide important information about the makeup of the population tested. A *skewed* distribution (Figure 3.6, A) shows at a glance that more people make high (or low) scores than make intermediate scores. Our figure shows two curves, one skewed in each direction.

Sometimes, instead of approximating normality, or being skewed in one direction or the other, a curve will be *bimodal*. That is to say, instead of only one score with a relatively high frequency, there will be two such scores. These may be equally high as shown

in Figure 3.6 (B), or they may be high but unequal.

Bimodal curves are especially evident when there are two different groups in the population tested — say, a skilled and an unskilled group, or a group with a low level of education and a group that is college trained. Thus a distribution of intelligence test scores for soldiers with only a fourth-grade education and those with a college education had two modes, one at around 20 points and the other at around 150.<sup>7</sup>

When different groups in a bimodal distribution are identified and separate curves drawn, the result is similar to that illustrated in Figure 3.6 (C), where it can be seen that there are really two overlapping distributions.

Although we have emphasized bimodality, it should be recognized that some distributions have more than two modes. These are referred to as *multimodal*.

When two or more groups (male-female, for example) are given the same test, it is customary to find overlapping. Sometimes, of course, the overlap is complete. The distributions of intelligence for men and women, for example, are practically identical. A test of strength with a dynamometer, on the other hand, yields somewhat different distributions, with much overlapping, but with boys ahead of girls. In some tests, and especially those involving linguistic skills, girls are ahead, but there is considerable overlapping.

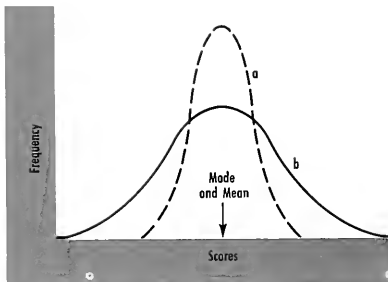
An example of overlapping male and female distributions appears in Figure 3.7. The test required completion of partially-given sen-

tences. Observe that women made higher modal scores than men. The female average was also higher than the male average.

When overlapping exists, whether or not the modes or means of the two distributions differ, it is well to remember that a certain proportion of one group exceeds the mode or mean of the other. Some women are stronger, for example, than the average man and some men have better verbal skills than the average woman.

### Variability as revealed by a distribution curve

Frequency distributions also give us information about the extent of individual differences. The overall spread (highest minus lowest score) is the *range*. But another index of variability (see Statistical Appendix) represents the degree to which scores are clustered around the central tendency (mean or mode). If scores are piled up at the center of the distribution, with very little spread in either direction, it is evident that differences in what is represented are not large. If there is a wide spread, on the other hand, one can see that differences within the group are relatively large. Two distributions, one with a large and the other with a relatively small spread of scores are shown in Figure 3.8. In statistical terminology we would



### 3.8 Distributions Differing in Variability.

Although the modes (and means) of the two distributions are identical, there is more spread (variability) in the *b* distribution.

say that there is less *variability* in the *a* than in the *b* group. Although our example shows two groups with the same mean, it usually happens that different groups differ in their mean scores and also in their variability.

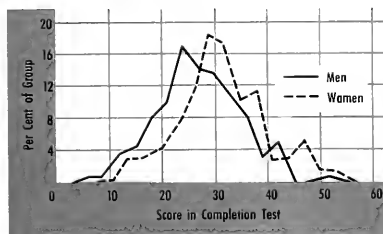
### THE STATUS OF THE INDIVIDUAL

A mean or a measure of variability does not tell us the status of a particular person. The mean grade or the variability of your college class, for example, would not tell us your standing in the class. Knowing your score and knowing the mean, however, we could say whether your performance was higher or lower than that represented by the latter. But there are several other ways in which your standing might be indicated, and more specifically than in the example given. One of these is, of course, to say how far your performance deviates upward or downward from the mean, or how much it deviates from the maximum or minimum performance. This can be done in terms of actual scores or in terms of rank standing.

One method widely used to indicate the rank standing of an individual score utilizes *percentiles*. Rank is then indicated in terms of the percentage of the scores above or below this score. Since there were 100 subjects in our memory span experiment, we can give a rough idea of the meaning of percentiles by indicating that the person with a memory span

### 3.7 Overlapping Distributions for Men and Women College Students on a Sentence-Completion Test.

The average female score was 30, the average male score 26. The latter score was exceeded by 70 per cent of the women. Psychological tests do not usually reveal such a large sex difference. (From Woodworth, and Marquis, *Psychology* (5th ed.). Holt, 1947, p. 193.)



of 9 had a higher span than 99 per cent of the group. It was in the upper one-hundredth. His percentile rank was therefore between 99 and 100. No more precise statement than this would be warranted in the present case. However, when there are large numbers of scores and percentiles are calculated for the whole range of data, we can tell at a glance the percentile standing of any particular score.

Suppose we find that an individual's score is in the 90th percentile. This means that it is equalled or exceeded by 10 per cent of the scores.

Statisticians have worked out other ways to indicate the status of an individual score and some are superior to the observation merely that the score is above or below the mean or that it is equalled or exceeded by a certain percentage of the group. One of these methods, as indicated in the Statistical Appendix (pp. 537-542), evaluates a score in terms of: (1) how far it deviates from the mean, and (2) the spread (i.e., variability) of the distribution in which it occurs. The score thus evaluated is known as a *standard score*. To learn how standard scores are calculated see the previously mentioned appendix. One will also find there a figure which compares percentile and standard scores derived from a normal distribution.

## CORRELATION

Individual differences in one ability are often related to individual differences in other abilities. The reader may recall, in this connection, our earlier discussion of R-R laws — those relating one type of response to another. There may, for instance, be a relation between performance on an intelligence test and performance in school such that the higher the test performance the higher the school grades. In this event, analysis of the data with suitable statistical techniques would reveal the presence of a *positive correlation* between scores on the intelligence test and school grades.

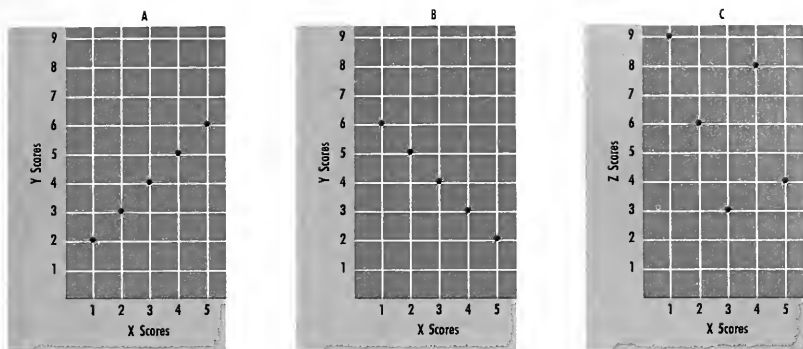
The correlations mentioned in our discussion of test reliability were all positive. Quite often, however, we correlate one set of scores with another and find that there is no relationship. There is, for example, no relation between the height of the forehead and intelli-

gence or between motor dexterity and vocabulary. In both of these instances we would say that there is *zero correlation*.

Of course the correlation between two traits may be anywhere between zero and 1.00, as indicated in earlier discussions. Nevertheless, some traits are related in such a way that a high value in one goes with a low value in the other. There may be a relation between weight and speed of running, for example, such that the heavier the runner the slower his speed. In this event we would have a *negative correlation*. Negative correlations might range anywhere from zero to -1.00.

Note that, even though a relationship is negative, a correlation *does* exist. Here is an example. There is a correlation of .40 between measurements of a personality trait known as *extraversion* and measurements of another personality trait known as *dominance*. But suppose we evaluate the same results in terms of the opposite trait to dominance — that is, *submissiveness*? Now we may obtain a correlation of -.40. We can then say that extraverts tend to be dominant or that extraverts do not tend to be submissive. In either case there is a relationship.

Correlation techniques like those described in the Statistical Appendix are used to answer questions about many aspects of individual differences. In addition to discovering the reliability of measurements and possible relations between performances on one test and performances on another, these techniques are used to answer a variety of questions. For example: Identical twins have identical heredity and fraternal twins do not. Is there, then, a greater psychological similarity between the former than between the latter? Other things being equal, a significantly higher correlation between the traits of identical twins than between those of fraternal twins would suggest the strong influence of heredity in making people alike. Other relevant questions are: What is the correlation between intelligence and differences in economic status, or educational opportunities, or differences in the home environment? In each instance we must measure the variables in question. In the case of home environment, for instance, different homes would have to be rated in some way — perhaps in terms of the presence of books and other enriching aspects.



**3.9 Scatter Diagrams Showing Different Degrees of Correlation.** In **A** is shown the scattergram for the correlation between **X** and **Y**. It is interpreted as follows: Subject **A** made one error on **X** and two errors on **Y**; so we represent him with a point at **X** one and **Y** two. We do this with each subject. When the scores thus arranged slope toward the right as illustrated in **A**, the correlation is a perfect positive one. The diagram shows at a glance that the higher a subject's score in **X**, the higher his score in **Y**. If we reverse the figures, assuming that **A**, who made one error on **X**, made 6 on **Y**, and so on, we get the scattergram shown in **B**. This represents a perfect negative correlation. That is to say, the fewer errors made in solving one problem, the more there are in solving the other. In **C** the correlation, as one can judge from inspection, is negative, but of doubtful magnitude. We know that it is negative because three of the cases slope definitely to the left as in **B**. Calculation (see Appendix) shows that the correlation in **C** is actually  $-.52$ .

#### The coefficient of correlation

The most commonly used measure of correlation yields a *coefficient of correlation* otherwise referred to as  $r$ . Calculation of  $r$  is demonstrated in the Statistical Appendix. As a further illustration of much that we have been discussing, however, the graphs in Figure 3.9 have been drawn. These are known as *scatter diagrams*. Comparable graphs are frequently used to represent the degree of correlation between two variables. The data represented here are of course hypothetical. We assume that subjects **A**, **B**, **C**, **D**, and **E** were each required to solve three problems, **X**, **Y**, and **Z**. Their errors were, let us say, those tabulated at the right.

We see that subject **A** made only one error before learning problem **X**, 2 before learning problem **Y**, and 9 before learning problem **Z**. One will note immediately that subject **A** made

Subjects	Errors made in learning three problems		
	X	Y	Z
A	1	2	9
B	2	3	6
C	3	4	3
D	4	5	8
E	5	6	4

the lowest number of errors in **X** and also the lowest number in **Y**; that subject **B** made the next to lowest number of errors in **X**, and the next to lowest number of errors in **Y**; and so on, down to subject **E**, who made the greatest number of errors in both **X** and **Y**. The correlation here is of course  $+1.00$ .

Suppose, now, that we should have the error scores for **X** (or **Y**) in reverse order—that the person who made the smallest number of errors in **X** made the greatest number

of errors in Y, the person who made the next lowest number of errors in X made the next to highest number in Y, and so on. Such an arrangement would give us a perfect negative correlation; that is, a correlation of  $-1.00$ . Our remaining example illustrates another correlation. The exact correlation is not as evident from the scatter diagram, as were those for  $r$ 's of  $1.00$  and  $-1.00$ . Actually, as calculated in the Statistical Appendix, the coefficient here is  $-.52$ .

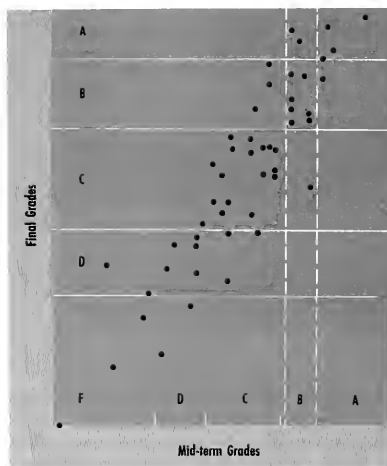
#### Interpretation of $r$

Providing that statistical evaluation shows it to be reliable — that is, dependable or unlikely to disappear in repetitions of the experiment —  $r$  is accepted as revealing or failing to reveal a relationship between the variables correlated. The higher  $r$  is found to be, the greater the relationship (positive or negative) between the variables correlated.

But what does a reliable  $r$  of a certain magnitude indicate concerning the degree of relationship? Students frequently, and quite erroneously, think of  $r$  as indicating the per cent of relationship between two variables. Now, it is quite evident, from our simple scatter plots of perfect correlations, that here we have a 100 per cent relationship between X and Y. But this holds only for an  $r$  of plus or minus  $1.00$ .

According to one method of calculating the dependence of X on Y, when the two are correlated, even an  $r$  of  $.99$  would indicate only 88 per cent dependence. The per cent of dependence drops rapidly, so that an  $r$  of  $.50$  indicates only 37 per cent dependence.<sup>8</sup>

From a somewhat different angle we may ask, "With what degree of accuracy does a certain  $r$  allow us to predict scores in Y from scores in X?" One can see from our first scatter diagram that, when  $r$  is  $1.00$ , it is possible to predict Y from an individual's X score. There is no need to give him test Y. However, the predictability of one score from another decreases rapidly as  $r$  becomes smaller. In Figure 3.10, for example, is a scatter diagram representing the midterm and final grades of 50 students in an introductory course in psychology.<sup>9</sup> The correlation is  $.90$ , indicating a high probability that final grades will be closely equivalent in value to midterm grades. Observe, however, the discrepancies between



**3.10** A Scattergram of Midterm and Final Grades. Variations in the position of the 50 dots, each representing one student, are based upon points made on the tests. Our discussion is concerned only with the letter grades and, more specifically, with prediction of final grades from B grades at midterm. (After Kimble, G. A., *Principles of General Psychology*. Ronald, 1956, p. 47.)

midterm and final grades. Suppose we had predicted that students who made B at the midterm would get a B in the course. There were 10 with midterm B's. But only seven of these made a final B. Of the remaining three, two went up to an A and one dropped to a C. Our prediction would have erred, but of course only by one grade in either direction. Generally speaking, prediction from this particular set of data would have been about 75 per cent accurate.

#### Does $r$ signify a causal relationship?

The fact that variables are correlated does not mean that one is the cause of the other. They may both be dependent upon a third factor. In growing children, for instance, weight and intelligence are positively correlated. But one would not conclude that weight determines intelligence, or vice versa.



Actually this correlation is spurious. It depends upon the fact that both weight and intelligence increase with a third variable, the child's age. This is quite evident when we correlate intelligence and weight in children of the same age. When we do this the correlation between weight and age becomes negligible.

As another example we may take the correlation between intelligence test scores and college grades where the  $r$  is often found to be as high as .60. This relationship means that factors contributing to intelligence test performance are also contributing to academic performance. Linguistic versatility is certainly involved in both kinds of performance. The ability to concentrate attention on the task at hand is also certainly involved. There are doubtless many such overlapping skills.

Absence of a higher correlation between intelligence and college grades may result from lack of sustained interest such as good scholastic performance requires, preoccupation with extracurricular activities, and possession of personality characteristics which are not measured by an intelligence test but which are also important in academic success.

Thus a coefficient of correlation is not to be taken at its face value. There are various ways of interpreting it, both from the standpoint of the actual magnitude of the relationship and from the standpoint of what it means in terms of possible causal or contributing influences.

### HOW INDIVIDUAL DIFFERENCES ORIGINATE

Each of us undergoes a long process of development which begins at fertilization and continues until maturity. For many, psychological development continues until senescence. Here we are not so much interested in the developmental process as we are in associated conditions which make us differ.

At the time of fertilization and for some weeks thereafter we are to all appearances identical. As growth continues, however, differences become increasingly apparent. When examined even casually, newborn babies look very different not only in size and sexual characteristics but in many other ways. Their behavior also differs. Some are more active than others, some cry more, and some have better

appetites. As the weeks, months, and years go by the characteristics in which individuals differ become so numerous that it is difficult to catalogue them.

Since we all have such a similar beginning, it is interesting to ask what makes us so different as we grow older. One answer is that, except in the case of identical twins, we have different heredity. Another answer is that we have different environments. There is, however, a constant interplay between hereditary and environmental influences and our physical and mental characteristics are complex resultants of both factors.

Heredity is a constant factor, established at the time of fertilization. The individual's environment, on the other hand, is continually expanding. From the relatively simple chemical environment of the newly conceived organism we get, eventually, to the highly complicated social environment of people, books, schools, and so forth. It is interesting to note, moreover, that although heredity is a constant factor, its potentialities are realized at different stages of growth and always in relation to present and past environmental conditions.

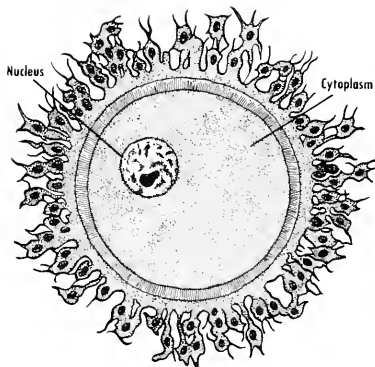
The following discussions are designed to answer such questions as: "What is heredity?" "How does it produce individual differences?" "What is meant by environment?" "What are the different kinds of environmental influence?" "In what ways are differences dependent upon environment? How do heredity and environment interact to produce individual differences? How is it possible to differentiate their respective influence?"

### HEREDITY

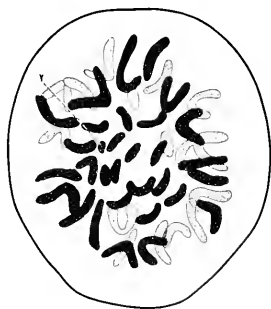
Each of us begins life as a single fertilized cell smaller than the head of a pin. This fertilized egg (ovum) has a nucleus surrounded by cytoplasm, as shown in Figure 3.11. The determiners of heredity are complex organizations of chemical materials within the nucleus. More specifically, they are contained in nuclear structures which, because they show up when stained, are known as *chromosomes*, or colored bodies.\*

Microscopic studies of human body cells

\* Human beings were long thought to have forty-eight chromosomes but recent observations suggest that the correct figure is forty-six.



**3.11 A Human Ovum.** The ovum comprises the nucleus, cytoplasm, and surrounding membranes. Cells shown on the outside belong to the mother, not to the ovum. (After Arey.)



**3.12 Human Chromosomes.** This is a male cell, as indicated by the Y chromosome which is found only in males. (After Evans and Swezy.)

show that chromosomes come in pairs. Females have twenty-three pairs. Males have twenty-two pairs, plus two singles. One of these, identified in Figure 3.12, is the Y chromosome found only in males. Females have a pair of X chromosomes while males have only one. The X and Y are called sex chromosomes because our sex depends upon whether we get the XX or XY combination.

Sets of chromosomes from different persons of the same sex look very much alike. Since they are chromosomes characteristic of the human race, we would expect this. But, except in the case of identical twins, the similar-looking chromosomes of different persons actually differ internally. These differences are most pronounced in unrelated individuals.

#### Genes

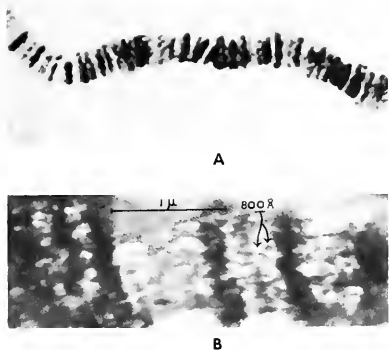
All of our innumerable inherited characteristics are represented in the forty-six chromosomes. Thus each chromosome must carry many determiners. From this fact, and the way in which inherited characteristics, singly and in diverse combinations, are transmitted from one generation to another, geneticists long ago inferred that the chromosomes must be differentiated internally. It was assumed, in other words, that different regions of a chromosome determine different characteristics, like eye color, skin texture, and so on. Some of these regions were located and represented on chromosome maps.

The hereditary factors hidden within the chromosomes were called *genes* (which means determiners). They were assumed to be "packets of chemicals" strung along the chromosome like beads on a thread or peas in a pod. But nobody had yet seen anything that might be identified as a gene.

Then geneticists discovered that the salivary gland of the fruit fly contains exceptionally large chromosomes which, when viewed microscopically, have dark and light bands throughout their length (Figure 3.13, A). The genes were thought to be in these bands. Now the electron microscope reveals the sort of detail shown in Figure 3.13 (B), which represents a piece of salivary gland chromosome magnified 26,000 times. Observers of this, and even higher magnifications, believe that "the discrete particles" they have seen are genes.<sup>10</sup> One chemical constituent of genes<sup>9</sup> has also been identified and referred to as an "hereditary chemical."<sup>11</sup>

Action of the genes on cytoplasm changes the shape and other characteristics of cells. Genes, combined with internal environmental conditions, change cells from their original shape to form the great variety (muscle, bone, nerve, and so on) which make up the response

<sup>9</sup> deoxyribonucleic acid (DNA, for short)



**3.13 A Portion of a Salivary Gland Chromosome.** This is one of the giant chromosomes of the fruit fly's salivary gland. **A** shows such a chromosome under a high-powered microscope. **B** is not a photograph, but an electron micrograph of a very small portion of a salivary gland chromosome. The differentiations, enlarged here 26,000 times, are believed to be, or to contain, genes. (From Pease, D. C., and R. F. Boker, 10, p. 9.)

mechanisms. Each gene may, in combinations with other genes, produce a variety of characteristics.

#### Multiplication of cells

When a fertilized ovum is about to divide, its chromosomes (and genes) are duplicated. A complete set is subsequently passed on to each resulting cell. Through this process of chromosome duplication and cell division, all except reproductive cells (to be discussed

in detail later) receive an identical inheritance.

Sometimes, instead of remaining together as parts of a single organism, the cells separate and form two or more identical organisms. This is how identical twins (Figure 3.14) originate.\* Siamese twins come from an incomplete separation of identical cells. Identical quadruplets are obtained through separation at the four-celled stage.

In all subsequent divisions of cells, up to the time of puberty, when reproductive cells develop, the chromosomes are duplicated as already described. This process will be made more meaningful through careful study of Figure 3.15, which shows diagrammatically how a fertilized ovum is changed to produce two cells, then four, eight, and so on.

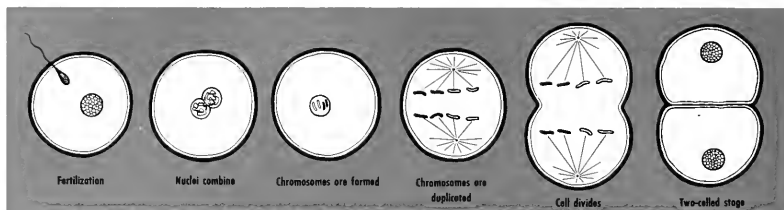
#### Maturation of reproductive cells

At the time of puberty, cells set aside for reproductive purposes undergo a kind of division different from that described. Instead of the chromosomes being split and duplicated just prior to cell division, one member of a pair goes to each new cell. Thus, each cell has only one-half of the chromosomes, twenty-three instead of forty-six. The ovum gets only one-half of the mother's chromosomes and the sperm only one-half of the father's. Different ova (or sperms) produced by the same individual receive different combinations of chromosomes. Which twenty-three of the forty-six chromosomes shall go to a particular ovum or sperm is determined by "chance."

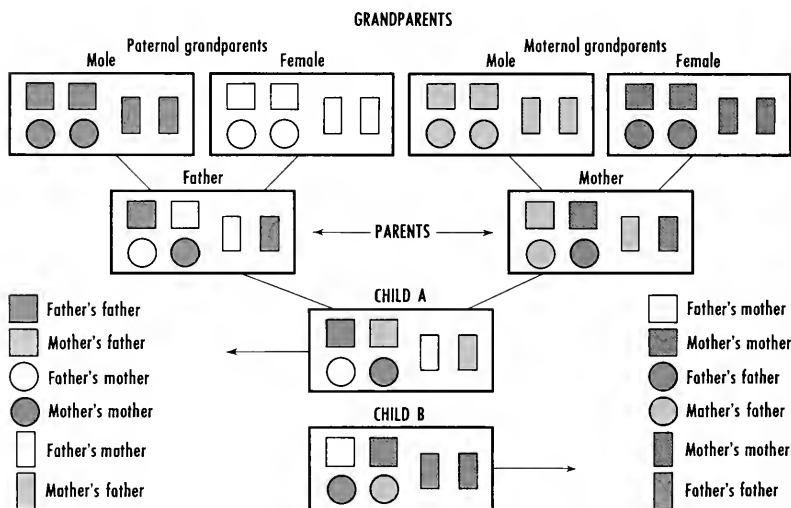
\* Fraternal twins develop from separate fertilized ova, rather than from the cleavage of one ovum. Thus their heredity is no more alike than that of children from the same parents but born at different times.

**3.14 Identical Twins and How They Originated.** A fertilized ovum (left) divided and, instead of staying together as one organism, the two cells separated to begin the development of two identical individuals. (From the film, *Human Heredity*, produced and distributed by the E. C. Brown Trust, Portland, Oregon.)





**3.15 Division of a Fertilized Ovum to Produce Two Cells.** After the two-celled stage is reached, a similar process of division produces four cells then eight, and so on, until billions are produced.



**3.16 How Our Grandparents Contribute to Our Inheritance.** Here we have, for purposes of simplicity, assumed that only 6 instead of 46 chromosomes are involved. Observe that the four grandparents may contribute different numbers and kinds of chromosomes to their grandchildren. Only two of many possible combinations are illustrated. At the time when sperms are developed, the set of chromosomes coming from the potential father's parents is a "chance" affair. Theoretically, they may be all from his mother or all from his father. Likewise, the contributions of each parent of the potential mother are determined by "chance." One half of the chromosomes must come from the mother's parents and one half from the father's, as indicated, but how much each grandparent has actually contributed cannot, of course, be known.

Fertilization re-establishes the full complement of chromosomes. Which sperm (which set of twenty-three chromosomes from the male) will unite with which ovum (which set of twenty-three chromosomes from the female) to produce the new individual is again a matter of "chance." The laws of inheritance are laws relating to (1) the "chance" assortment of chromosomes within ova and sperm, and (2) the "chance" association of particular sperms and ova at fertilization.

During the production of sperms and ova and the process of fertilization, the contribution of each grandparent is also determined in a "chance" fashion. This contribution is illustrated in Figure 3.16 and discussed in the legend.

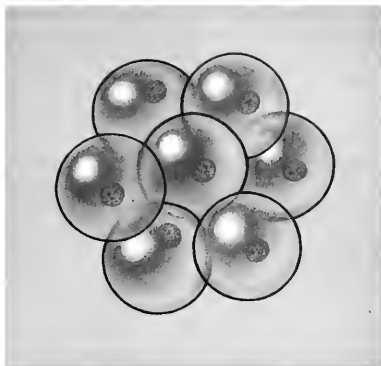
### ENVIRONMENT

The most obvious environmental influences are those which act upon the organism from without, and especially those which operate after birth has occurred. There exists, however, an internal environment which, at the earlier stages of development, is more influential than the external environment.

#### The internal environment

The nucleus, with its chromosomes and their genes, is surrounded by a jelly-like substance known as cytoplasm. This substance was illustrated in the picture of a human ovum with which our discussion of heredity began. The cytoplasm is often referred to as an *intracellular environment* because the genes surrounded by it are influenced by and in turn influence its characteristics. In fact what the organism becomes is determined by its cytoplasm as well as its heredity. In lower organisms one can sometimes change the cytoplasm without altering the nucleus. What then results is an organism different from that which normally develops.<sup>12</sup>

After the interaction of genes and cytoplasm has produced several cells (each with identical heredity) a new internal environment comes into existence. The cells press one upon the other. Some influence their neighbors chemically and electrically. We thus have the sort of *intercellular environment* represented by Figure 3.17.



**3.17 The Early Intercellular Environment of a Cell.** When several cells have developed, those which surround a given cell (center) constitute its intercellular environment.

Experimental embryologists have changed the position of certain cells, with respect to others, and these have developed characteristics appropriate to their new location. This ability of certain cells to substitute for others is attributable to the possession of the same hereditary factors by all cells. Nevertheless, the actual structure of a cell depends upon its relation to other cells.<sup>13</sup> Developing in one location, the cellular substance becomes brain tissue; developing in another location, the same substance becomes part of the visual mechanism.

Later, when the endocrine glands develop and pour their hormones into the blood stream, still another intercellular influence is produced.

Hormones are important for further development of the entire organism. Indeed many deformities evident at birth are the result of overactive or underactive endocrine functioning. Other chemical characteristics of the blood are also important for development.

We have discussed the internal environment only as it influences early growth and produces individual differences. However, one should not overlook the continuing importance of the internal environment of blood (with its hor-

mones and other products). It continues to be a major influence throughout life.

### External environments

As the cells multiply and become transformed to serve their respective functions, the embryo itself emerges and becomes increasingly complex. Then the growing organism is surrounded by amniotic fluid and attached to the mother by what becomes its umbilical cord. Through the latter, nourishment is obtained and waste products are excreted. This *pre-natal external environment* is extremely important, for normal development can proceed only providing the liquid which surrounds the organism has the proper thermal and chemical properties. Moreover, nourishment coming from the mother's bloodstream must have properties that are conducive to proper growth.

After birth there is the broader external environment with its immense variety of physical and social contacts. This is what we customarily think of as the environment. One part of it, our social environment, includes language, customs, and many other aspects of culture. Together, these comprise our *social heritage*.

From the time of conception on, there is a constant interplay of hereditary and environmental influences. It is this interplay that we shall now consider.

**3.18 Polydactyly.** The inheritance of six fingers and six toes runs in certain families. Sometimes the extra finger is removed surgically. (Photo courtesy of C. Nash Herndon.)



**3.19 Feeble-mindedness.** These inmates of a home for the feeble-minded are daughters of patients who were at one time also in the same institution. Because this variety of feeble-mindedness runs in families, it is assumed to be hereditary. Some feeble-mindedness (see p. 71) is environmentally determined. (*Survival of the Unfittest*, (Pamphlet) Birthright, 1946, p. 11. Courtesy of the Human Betterment Association of America, Inc., formerly "Birthright.")

### HEREDITY AND ENVIRONMENT

Some babies are born with physical and psychological abnormalities which depend almost entirely on defective heredity. Others are born with similar abnormalities, but which in their case are determined almost exclusively by a defective prenatal environment. A study of such cases suggests the respective parts played in prenatal development by hereditary factors and environmental conditions.

#### Hereditary abnormalities

These seldom occur in isolation. They crop up here and there among related individuals. These anomalies occur, too, in related persons with different mothers, which would mean different prenatal environments. Some examples of rather obvious hereditary defects are the "lobster claw," which appeared in a man and both of his children; the absence of hands and feet, which happened in a father and six out of twelve of his children; and polydactyly (Figure 3.18) which runs in families.<sup>14</sup> Such bodily changes, appearing suddenly and thereafter inheritable, are known as *mutations*. They are due to alterations in chromosomes or genes. Many mutations occur spontaneously. However the mutation rate is greatly accelerated by ra-

diation, which also produces mutations not otherwise found.

In addition to inherited bodily abnormalities directly attributable to mutations, there are numerous behavior disorders which appear repeatedly through generation after generation of certain families. Among these is a nervous affliction known as Huntington's chorea, and certain kinds of feeble-mindedness (Figure 3.19).

#### **Environmentally produced abnormalities**

Many abnormalities result from defective prenatal environments. These are isolated occurrences. They appear in related individuals no more often than in those who are unrelated. In many instances, the environmental defect is apparent. Here, for example, is a boy whose arm is withered because the umbilical cord twisted around it during the fetal period. Here is a physically deformed organism whose prenatal quarters were too cramped, or who maintained during the fetal period a position not conducive to normal growth of certain structures.

If the mother's blood stream does not supply enough calcium, abnormalities of the skeleton appear. If her blood sugar is too high as a result of diabetes, the pancreas of her fetus may work excessively. This excessive functioning may continue at birth, reducing the blood sugar of the infant so much that, unless special treatment is given, it dies from insufficiency of glycogen (i.e., from hypoglycemia).

Many cases of abnormal head and brain development are believed to result from improper prenatal conditions — perhaps chemical inadequacies of the mother's blood. Head injuries at birth, either through prolonged pressure on the head during a difficult labor or from instrumental delivery, often result in spastic paralysis, feeble-mindedness, epilepsy, and other defects. All defects produced in these ways are, of course, environmental. Heredity has nothing whatsoever to do with them.

#### **Significance of the postnatal environment**

The external environment after birth is extremely variable, and unrelated to the sort of genes which the individual has. No two human beings even living in the same home and

going to the same school, have the same environment. Geographically and socially their environment may seem the same. From the standpoint of its effect on their development, however, it may be quite different. Different individuals within the same environment meet different people and are influenced differently by the same people. They develop different interests and attitudes, and they identify themselves with different groups — religious, political, and recreational.

The fact that the postnatal environment is so variable and its effects so unpredictable makes it difficult for us to discover the relative influence of heredity and environment on psychological development after birth.

Every one of us, as we have said before, is a product of both heredity and environment. We could not develop without genes, and the genes could have no effect without normal surrounding tissues. But is the difference between Mary Brown and Jane Smith due to a difference in their heredity, or in their environment? Unless they are identical twins, with different names, as in some cases to be mentioned shortly, they have a different heredity; and some of the difference between them is attributable to this. They certainly have somewhat different environments, even if living in the same home. And part of the difference, especially in psychological characteristics, is attributable to this. The difference, therefore, between two or more individuals is normally attributable to both heredity and environment.

Which is more important in producing these differences — heredity or environment? The answer depends upon what traits are under examination. Any difference in the appearance and other physical characteristics of Mary Brown and Jane Smith at birth is due primarily to their different genes, for it is probable that their environments before birth were similar. Even after birth, the difference in their environments would produce only superficial differences in physique. But how about traits like intelligence? One may be much brighter than the other. Here again, the difference in their genes may be important, but we cannot be as sure as in the case of physical traits.

The only scientific procedure that can be used in studying the relative influence of hereditary factors and environment on physique, intelligence, personality, or other charac-



**3.20 Identical Twins Reared Apart.** These twins, as described in the text, were reared apart for 23 years, one in a rural and the other in an urban environment. When tested at 23 years, the difference in their I.Q.'s was two points. (From H. H. Newman. Reprinted by special permission of *The Journal of Heredity*.)

teristics is to hold either heredity or environment constant while the other is varied. The possibility of carrying out such experiments with human beings is limited. We cannot mate persons of known heredity so as to control the inheritance of their offspring as, for example, we can mate mice or rats. Nor can we subject human beings to a constant environment, because what appears to be the same environment is not psychologically the same.

#### EXPERIMENTS WITH HEREDITY AND ENVIRONMENT—HEREDITY CONSTANT

Nature has provided us with some help in holding heredity constant by occasionally producing identical twins. Normally, these are reared together in the same home and, while their environment is not psychologically the same, it is more similar than in the case of individuals not so intimately related. Generally speaking, identical twins have very similar educational opportunities and in view of this and their identical heredity, it is not surprising that the average difference in their I.Q.'s (intelligence quotients) is only around six points. Fraternal twins differ in heredity but usually have somewhat comparable educational opportunities. The average difference in their I.Q.'s is around ten points.<sup>15</sup>

Is the closer physical and psychological similarity of identical twins due to their identical heredity, their similar environment, or both?

We cannot vary their environment, merely to see what effect this will have. But again, nature, or perhaps we should say society, has come to our aid; for identical twins are sometimes adopted into different homes and localities.

Data have now been reported for at least twenty-five pairs of separated identical twins. In appearance and in other purely physical characteristics the twins, when brought together again, are found to be very much alike. Those in Figure 3.20, for example, were separated at two months. Paul C, the twin on the left, lived in a small town until thirteen, in a larger town for two years, and finally in a medium-sized city. He completed high school at eighteen, after which he took some business courses while working. His brother, Paul O, lived for the most part in rural environments, shifting from place to place a great deal because his foster father, a telegraph operator, moved from one job to another. This twin completed high school at the same age as his brother. After less than one year in college, where mathematics proved a stumbling block, Paul O became an assistant postmaster.

When these twins were brought together and tested at twenty-three, the I.Q. difference was only two points. It should be noted, however, that they had a somewhat comparable schooling. Among other twins, some of whom differed more widely in educational opportunity, the differences in I.Q. ranged up to twenty-four points. It is interesting to observe,



moreover, that there was a fairly high and significant correlation ( $r$  of .79) between educational advantages (as estimated from schooling and other data) and the magnitude of the difference in I.Q.<sup>16</sup> This correlation suggests that, even in persons of the same heredity, differences in educational opportunity produce significant differences in the abilities measured by intelligence tests.

The average difference in I.Q. for identical twins reared apart is around eight points. This is about two points more than in those reared together. In personality traits the separated twins were sometimes very similar and sometimes very different. By and large, however, there were larger differences in personality than in I.Q.

We see, then, that identical heredity makes individuals very much alike in physique, somewhat less alike in I.Q., and still less alike in personality. With respect to I.Q. and personality the effect of environmental differences is relatively large.

#### EXPERIMENTS WITH HEREDITY AND ENVIRONMENT — ENVIRONMENT CONSTANT

It is impossible to hold the environment of two human beings strictly constant. We might hold the environment constant geographically and in almost every physical sense, even to the extent of having the same parents, the same home, the same school, and the same teachers. But its effective constancy could still not be guaranteed. Psychologically the environment might still be very different for one individual than for another. This is because human beings react selectively to the varied details of their surroundings. In the case of animals like mice and rats, on the other hand, we can approximate environmental constancy by rearing them in the same cages, in the same general surroundings, and with the same food and care. In view of the simplicity of such environments and the simplicity of the symbolic processes of these animals, it is unlikely that uncontrolled differences in the psychological environment are involved. Therefore, we can conduct experiments on heredity with assurance that hereditary factors rather than environmental variations are

responsible for the resulting differences in behavior.

There have been many experiments on the hereditary determination of behavior but we will restrict our discussion to three examples — a form of waltzing locomotion in mice, a tendency toward audiogenic seizures in mice, and maze-learning ability in rats.

#### Locomotion

Some mice have an inherent defect which produces a whirling or waltzing type of locomotion.<sup>17</sup> Let us take a female thus afflicted and mate her with a mouse which runs normally. We will need to suppose that both the female waltzer and the male runner come from stock that is pure with respect to the traits under consideration.

It will be recalled that genes come in pairs. Pure-bred runners have genes which we will refer to as  $RR$ . Capitals are used because the gene for running is *dominant*. If it appears with a gene for waltzing, that is, the possessor of this combination will run rather than waltz. The ineffective gene is said to be *recessive* and it is customarily referred to by use of a lower case letter, in this instance  $r$ . Our female waltzers, then, must have the gene combination  $rr$ .

Every sperm of normal pure bred males has an  $R$  gene and every ovum of pure bred waltzing females an  $r$  gene. The combination in all of their offspring must therefore be  $Rr$ . For this reason we would predict that all offspring will be runners, and this is what is found. But suppose we now mate  $Rr$  with  $Rr$  mice? Can the outcome again be predicted? It can, for there are, as shown in Figure 3.21, only two kinds of sperm ( $R$ ,  $r$ ) and two kinds of ova ( $R$ ,  $r$ ). Chance combinations of these at fertilization will result in one fourth of the offspring having  $RR$ , one half  $Rr$ , and one fourth  $rr$ . Moreover, because running is dominant, we can predict that three fourths of the offspring will be runners and one fourth waltzers, and our prediction is confirmed. This supposes, of course, that large numbers of individuals are involved. If only one litter of four mice were concerned, one might or might not obtain three runners and one waltzer.

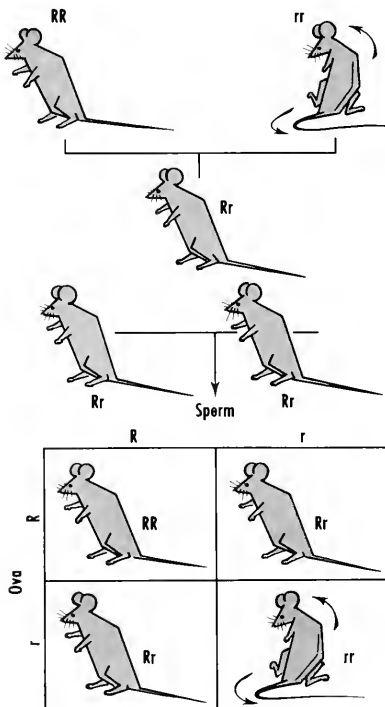
If dominance were not present, we would

find one fourth runners, one fourth waltzers, and one half with some sort of compromise between waltzing and running. Many inherited traits, including skin color in human beings, are dependent upon the combined effects of genes which are neither dominant nor recessive. Also, and this is true of skin color, many traits are dependent upon more than one gene pair. The waltzing example, therefore, is a comparatively simple one.

#### Audiogenic seizures

These seizures are so named because they are initiated by auditory stimulation. When stimulated with an intense high-pitched sound,

**3.21 Inheritance of Waltzing in Mice.** This is inheritance involving dominance of one trait, viz., normal locomotion. Observe that both waltzers are doubly recessive for this trait. (Modified from Sinnott and Dunn.)



some mice react much as if they were having epileptic seizures. After running widely in a circular path they fall to the floor (Figure 3.22) and go into convulsions. In one species of mouse, such a seizure is frequently followed by death.<sup>18</sup>

The fact that some mice react to high-pitched sounds by having a seizure and others do not suggests that susceptibility may be inherited. Efforts to discover hereditary factors have led to various results, depending upon the strain of animals involved. In the common house mouse, however, there is apparently a dominant gene for audiogenic susceptibility.<sup>19</sup> The dominant is here referred to as *As*, the recessive as *as*. If susceptibility were determined by *As* one would predict that a cross between purebred reactors and nonreactors would produce 100 per cent reactors. Actually the percentage of reactors in a group of 81 offspring of such a cross was 90. From a cross between these hybrid reactors (with a hypothetical *As*, *as* gene combination), one would expect 75 per cent reactors and 25 per cent nonreactors. The respective percentages actually found were 77 and 23; close enough to those predicted to lend support to the hypothesis that a single dominant gene is largely responsible for susceptibility. However, the discrepancies between predicted and actual percentages, as well as other considerations which need not concern us here, suggest that the *As* gene is supplemented by other genes in producing the above effects.

#### Maze-learning ability

One hundred and forty-two white rats were each given nineteen trials in a maze.<sup>20</sup> The number of entrances into blind alleys (errors) for each rat was recorded. The smallest number was 5, and the greatest 214. Rats making very few errors were designated *bright*, and those making many errors were designated *dull*.

Keeping the environment (food, lighting, caging, temperature, and so on) constant, the experimenter bred the brightest rats in each generation with each other. Likewise, he bred the dullest with the dullest. After following this procedure for seven generations, two races of rats — a bright and a dull — were developed. The situation the investigator had at the beginning and the one he had after seven



**3.22 Mice of Sensitive Strain in Audiogenic Convulsions.** Upon hearing a loud doorbell, they go into convulsions. (Courtesy of Dr. Benson E. Ginsburg and Dorothea S. Miller, whose research it illustrates. This is reported in Chapter 3 of Hooker, D., and C. Hare (Eds.), *Genetics and the Inheritance of Integrated Neurological and Psychiatric Patterns*. Williams and Wilkins, 1954. Photo by Wallace Kirkland, *Life*, © Time, Inc.)

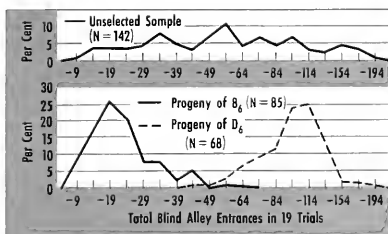
generations of selective breeding are illustrated in Figure 3.23.

At the beginning, the rats were distributed so that most of them made scores in about the middle of the two extremes. After seven generations, however, there was a bimodal distribution—a distribution in which many rats (the bright) made low error scores, and many other rats (the dull) made very high error scores. Few animals had ability in the middle of these extremes. Selective mating was continued through the eighteenth generation, but without producing any greater difference than that indicated.

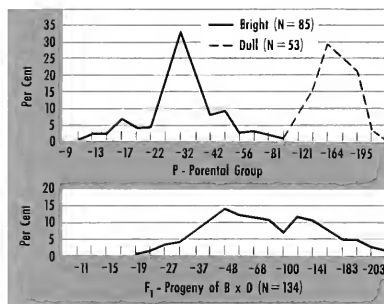
Bright and dull rats were then mated, with the result illustrated in Figure 3.24. One can see that mating bright and dull rats produced a distribution much like that with which the experiment began. There were now few bright and few dull rats. Rats of intermediate ability predominated.

In the same environment, therefore, marked differences in learning ability were produced by selective breeding, which means, of course, selecting genes.

Complex traits like maze-learning ability are



**3.23 Inheritance of Maze-Learning Ability in Rats.** In the parent generation, 142 rats, the number of errors made in 19 trials ranged from 5 to 214. The intermediate number of errors was made by around 12 per cent. Smaller percentages of rats made the successively lower and successively higher number of errors. The lower figure represents the seventh generation in which the dull (large number of errors) were mated with the dull, and the bright (small number of errors) were mated with the bright. It shows two races, a bright and a dull, with slight overlapping near the center of the error range. (From Tryon, R. C., 20, p. 113.)



**3.24 The Effect of Mating Bright and Dull Rats.** Observe that the bright rats had error scores ranging from 9 to around 80, while the dull rats had error scores ranging from around 80 to around 200. Very few rats had scores ranging from 40 to 100. In a cross of bright and dull rats, however, most of the rats had scores in this intermediate range. (From Tryon, R. C., 20, p. 115.)

doubtless influenced by many genes. It has been posited, in fact, that multiple genes, each with two degrees of expression, determine the maze-learning ability of rats. One gene, for example, may have the degrees of expression *A* and *a*, another the degrees of expression *B* and *b*, still another *C* and *c* — and so on for many relevant genes. It is assumed that a rat with the *AA* gene combination is, to this extent, brighter than the rat with the *aa* combination. A rat with the *Aa* pair of genes would then lie between the extremes. No dominance is assumed to exist.

If we assume that many genes determine maze-learning ability, and that each pair functions as above, the relevant genes possessed by the brightest possible rat would be *AABBCCDDEE*. . . . The dullest rat would have the genes *aabbccdde*. . . . A cross between such

rats would, in terms of probability, produce many combinations. Such combinations as *AaBbCcDdEe* . . . would occur with the highest frequency and there would be gradations toward the extremes of the distribution. If inheritance of maze-learning ability were determined in this way, we would expect that crossings of bright with dull rats would yield a normal distribution rather than the separate classes of animals obtained when, for example, single pairs of genes are involved. That is, instead of having bright rats, dull rats, and average rats (as we had runners and waltzers) we would have a distribution without breaks. This is, in fact, what was found in the above study. The frequency polygon representing errors, while it deviated from a normal frequency curve in some respects, was at least continuous and with the highest frequencies in an intermediate position.

It is a far cry from rats in a maze to human beings with their complex behavior mechanisms and their highly complex environment. Nevertheless there is every reason to believe that heredity operates in men as it does in rats. The number of chromosomes and genes is different, to be sure, but there are dominant and recessive genes and their random assortment is like that described in our first example. There are also genes whose effects blend, as in the determination of skin color and perhaps many structures which underlie differences in behavior. Human intelligence is also influenced by heredity, for we inherit our brain structures and these play a key role in learning and retention. The hereditary contribution to individual differences in human intelligence is no doubt determined by multiple genes complexly assorted. Integrated with hereditary complexity in this instance is environmental complexity. The relative influence of heredity and environment in determining differences in intelligence is given further consideration in the following chapter.

## Summary

Before individual differences can be studied scientifically it is necessary to measure individual traits. Some of these (like height, weight, and speed of reaction) are measurable in the absolute units (inches, pounds, seconds) of a ratio scale. Scales of this nature begin with zero and increase by equal increments. They allow us to say, for example, that one individual is twice as strong as another. But many psychological traits do not lend themselves to such measurement. The individual's score on an intelligence test or a rating scale has no absolute value. One must evaluate it in terms of what others do. When such measures are used, the scores are interpreted from the standpoint of their ordinal position, or rank. For this reason, such scales are referred to as ordinal. In general, the absolute measures of a ratio scale are more consistent (reliable or dependent) than the relative measures of an ordinal scale. Nevertheless, many psychological tests and rating scales are sufficiently reliable for measurement of individual differences. This is evident when we correlate two administrations of a test, or the ratings of behavior by one observer with the ratings of the same behavior by another observer.

After measurements have been made with a reliable test, the next step is to see what they reveal about individual differences. Here statistical devices are indispensable. We may begin by making a frequency distribution. From this we observe the modal (most frequent) score, the range (difference between the highest and lowest score), and how closely scores are bunched about the central tendency (mean or mode). A distribution may be represented graphically by a frequency polygon, a histogram, or a bar graph. When there are many cases, the frequency polygon may approximate a bell-shaped (normal probability) curve. In such a curve, scores pile up near the middle and have a decreasing frequency from here in both directions. Sometimes, however, scores are concentrated toward one end of the distribution. Such curves are said to be skewed. Some curves have two modes (bimodal) or several modes (multimodal). Distribution curves for differ-

ent groups given the same test may overlap more or less. This is of course true when their means are similar. There may be much overlapping, however, even when the means are far apart. The average strength of males is far greater than that of females, for instance, yet some females are stronger than the average male. There are also differences in variability. Two groups can have the same mean, yet differ in range and in other measures of variability (see Statistical Appendix).

An individual's status is indicated with respect to how much and in what direction his score differs from the mean, its rank, or its percentile standing. His score may, for example, be at the 75th percentile, in which case it is equalled or exceeded by 25 per cent of the scores.

Differences in one variable may be related to differences in another. This is indicated by a scatter graph or by more refined statistical calculations, one of which yields a coefficient of correlation, or  $r$ . This coefficient may be positive or negative. It may vary on the positive side from 0 to 1.00 and on the negative side from -1.00 to 0. The higher the correlation (positive or negative) the higher the relationship between the two variables. But  $r$  is not a percentage. Nor does it necessarily indicate causality.

The origins of individual differences are found in heredity and environment. Biological inheritance is determined by the chromosomes — more specifically by the genes (chemical determiners) within them.

Genes differ in certain respects from one person to another and this variation is the hereditary basis of individual differences. The genes interact with their most immediate environment, the cytoplasm of the cell (intracellular environment). As cells multiply, there is an influence of cell on cell (intercellular environment). Endocrine glands, for example, secrete hormones which influence the growth of other cells. The entire developing organism is surrounded by amniotic fluid, receives nourishment from the mother's circulatory system, and is subjected to various restrictions. These are features of the prenatal external

environment. Birth brings the individual into contact with new stimulation, including the social. It is through his social environment that he comes into contact with the social heritage — what has been transmitted culturally from former generations. Every trait is derived from an interplay of heredity and environment, but differences between individuals may be hereditary, environmental, or both. Thus, differences in eye color are hereditary, differences in social attitudes are environmental, and differences in intelligence are both hereditary and environmental — except in identical twins, where they are purely environmental.

It is only in animals that we can introduce hereditary variations while holding the environment constant. It has been shown, by way of example, that a certain form of abnormal locomotion, a susceptibility to audiogenic seizures, and maze-learning ability (brightness and dullness) are inherited. Maze-learning ability appears to depend upon the interaction of multiple pairs of genes.

There is no doubt that major differences in human intelligence (as the difference between brightness and dullness) are attributable largely to heredity. Evidence for this conclusion is presented in Chapter 4.

(References and notes for this chapter appear on page 543 of the Appendix.)

## Selected Readings

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Oxford University Press, 1958. More statistics for those with at least high school algebra.

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# Intelligence



The meaning of intelligence • Beginning of intelligence tests • The Stanford-Binet tests • The Wechsler tests • Performance tests of intelligence • Group tests • The search for factors in intelligence • The gifted child • Mental retardation • Individual differences in mental growth • The influence of unusual environments • Are there racial differences in intelligence? • The relative influence of heredity and environment • Summary

When we say that one organism is more intelligent than another, what do we mean? Why, for example, do we regard chimpanzees as less intelligent than men and more intelligent than rats? Why do we say that adults are more intelligent than children? And why do we look upon Einstein as more intelligent than most other men? The answer to such questions are given in this chapter.

In the last analysis, intelligence derives from ability to learn and to utilize what has been learned in adjusting to new situations and solving new problems. The concept of intelligence owes much to early studies of animal learning. About a century ago, following publication of Darwin's *Origin of Species*, there was a flurry of interest in the evolution of intelligence and many tests were devised to measure intelligence in animals ranging from ants to chimpanzees. These were tests of learning ability. The general procedure was to block a customary access to food or to introduce a disturbing element from which escape was possible.

An intelligence test for earthworms utilized a T-shaped maze. A bright light could be avoided by crawling along the stem of the T. When the animal reached the other end, it was confronted with two alternatives. If it went to the left, let us say, it escaped

the light and received no punishment. If it went to the right, however, it first made contact with some sandpaper, then with a grid which gave it an electric shock. At the beginning, a worm was as likely to turn in one direction as in the other. But after a certain number of trials, which differed from one worm to another, the right turn was avoided or, if the worm ventured as far as the sandpaper on this side, it turned back before reaching the electric grid. The number of trials required to reach a criterion of three errorless trials was the measure of intelligence. In terms of this criterion, some worms were much more intelligent than others.

Intelligence tests for rats require much more complicated learning tasks than those for worms. While a simple T-maze reveals wide differences between one worm and another, it reveals little or no difference between rats. This is because rat intelligence is much more complex than that of worms. A simple T-maze hardly utilizes the rat's learning capacity. What is needed for testing rat intelligence, then, is a much more complicated maze, a maze with many blind alleys instead of only one. We have already observed (pp. 75-76) that a complicated maze-learning task reveals a wide range of differences between rats and can be used as a measure of their "brightness" or "dullness." Rats also learn many other problems far too complex for worms. One of these is a puzzle-box problem, requiring that a latch be lifted or a string pulled in order to open the door giving access to food.

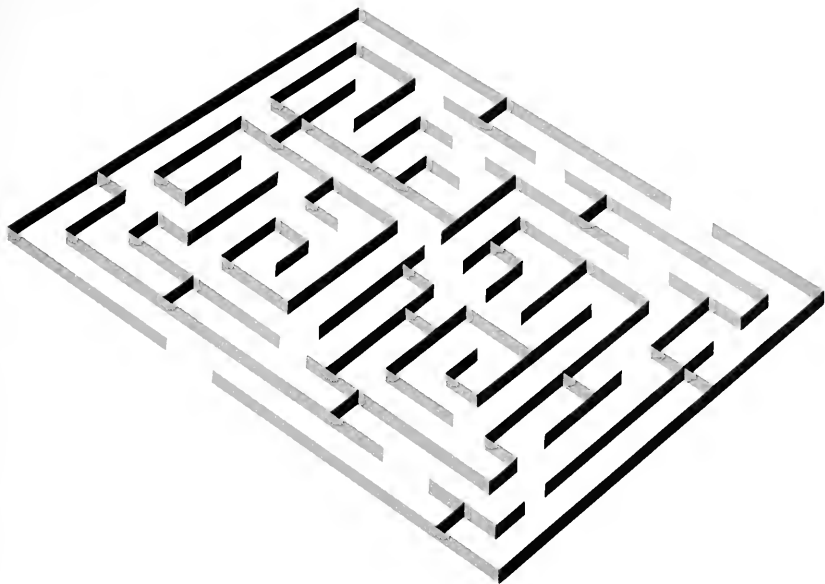
It is interesting to observe that, even at the human level, mazes are sometimes used to measure intelligence. But these must be more complicated than those used with rats. The ordinary rat maze, enlarged so that a man can walk through it, provides a poor measure of human intelligence. Human subjects do no better than rats in learning such a maze. This is also true when a small grooved replica of the maze is used and the blindfolded subject traces through it with a pencil.<sup>1</sup>

Why does the human subject do no better than a rat in such mazes? The chief reason is that only the elementary aspects of human intelligence are tapped by such a problem. It is somewhat comparable with using a worm maze to test a rat. Human beings have acquired symbolic processes, including language, and the limits of their learning ability can be tested only if the tests allow them to utilize these processes. The infant learns the meaning of certain stimuli and acquires simple skills, but it has very limited ability to think of things that are absent, to put two and two together, and to reason and verbalize. Children are three years of age or older before these typically human abilities develop. Thereafter, tests of human intelligence are too limited in nature unless they provide a chance to use such abilities.

In answering our question about the maze, we must say, then, that a rat maze can be learned with elementary learning processes. It allows little or no chance for figuring out a solution or for regulating one act in terms of what is known to lie ahead. A blind hit-or-miss approach, or letting "nature take its course," is just as effective as trying to figure out the plan of the alleys or trying to verbalize what one should do, such as "take the first turn to the left, then two right turns," and so on. If there is a plan, a definite sequence that can be memorized, this approach is helpful. But there may be many turns, in no regular sequence. Hence trying to memorize the turns may take more time than to learn on a hit-or-miss basis.

If one wants a maze that really gives the human subject an advantage over any other organism, he will use one comparable with that pictured in Figure 4.1. Here the subject can use symbolic processes. He can look ahead and figure out the path to be followed. He can avoid errors by anticipating the consequence of actions not yet taken, actions represented symbolically; perhaps imagined, or verbalized in the form — "If I do that, then I'll be blocked over here." Mazes like this are often used when the subjects to be



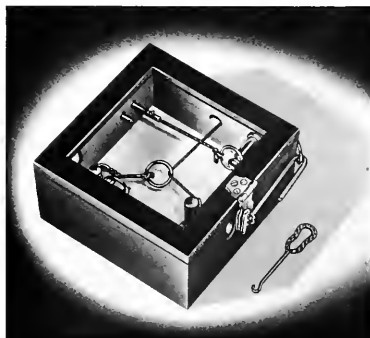


**4.1 A Maze Problem.** Attempt to trace through this maze from one opening to the other without entering a blind alley. Trace with a hairpin or something else which leaves no mark. (Courtesy International Telephone and Telegraph Company.)

tested are illiterate or for other reasons unable to follow complicated verbal instructions.

Puzzle boxes are also used in measuring human intelligence, but here again, they are much more complicated than those used with animals and they give the individual an opportunity to figure out the solution. One such puzzle box is shown in Figure 4.2. Here the individual who waits before he acts, and figures out the various moves to be made, does much better than the one who goes at it in a hit-or-miss manner. As in the case of mazes, however, such problems are used most widely when the subjects are illiterate or for other reasons unable to take the more widely used intelligence tests which depend so much upon language.

**4.2 The Healy Puzzle Box.** The box has holes at the sides through which the small end of a button-haak may be inserted. Application of the haak to the rings, in the proper way and in the correct sequence, releases the cards and allows the box to be opened. After the individual has opened the box, he may be given the more difficult task of putting it together again as pictured. (Courtesy C. H. Stoelting Co.)



We see, then, that the concept of intelligence is closely tied to learning ability. Tests of animal intelligence and mazes and puzzle boxes like those adapted for use with human subjects measure *learning in process*. The measure of intelligence is then the rapidity or accuracy of learning. The more widely used tests of human intelligence also place a premium on learning ability, but for the most part they measure learning accomplished before the test is taken. The basic idea is that, when individuals have been given comparable opportunities to learn, those who know most and can apply their knowledge best in answering the test items, are the most intelligent. We will observe, in this connection, that the items involved in intelligence tests utilize knowledge and skills which, presumably, everybody tested has at least had an opportunity to learn.

## THE MEANING OF INTELLIGENCE

Intelligence may be defined in various ways. The most general definition stresses versatility (or flexibility) of adjustment.<sup>2</sup> This has the virtue of being applicable at all levels of evolution. Versatility at lower levels is evidenced by the speed with which learning occurs. At somewhat higher levels, it has developed to the place where problems of greater complexity can be learned. Higher still we find symbolic processes beginning to play a role in adjustment. Observational learning is evident as well as ability to recall and to reason. These processes are most evident in human beings, hence the tests which most clearly measure differences in the versatility of human adjustment involve such complex symbolic processes as recall, reasoning, understanding of concepts, and linguistic skills. These processes are of major significance in human adjustment and tests built around them provide our best measures of human intelligence. We may say, therefore, that so far as human beings are concerned, intelligence is versatility in the use of symbolic processes.

Some psychologists define intelligence as ability to carry on abstract thinking. This is all right if we are considering only the human level, but it implies that most animals have no intelligence and it ignores the transition from one level of animal life to another, a transition revealed by animal experiments.

Some define intelligence as whatever it is the intelligence tests measure. This is true, presumably, but not very revealing. The reader may ask — "Well, *what* is it that they measure?" We could answer this by saying that, in the most general sense, they measure

differences in versatility of adjustment; differences which, at the human level, are most evident in the acquisition and use of symbolic processes.

One should recognize that the tests measure *differences in performance* and not intelligence directly. There is no way to measure intelligence as we measure strength. This point is raised because many students, when asked to define intelligence, think of it as some sort of power possessed by the individual. What we are dealing with — what we are measuring with intelligence tests — is a function which, to recall an earlier discussion, can usually be represented only in ordinal terms. In fact it is more correct to speak of one person as being more intelligent than another than it is to say that one has a given amount of intelligence. This will become increasingly apparent as the tests themselves are discussed.

### Intelligence and the organism

It is well to think of intelligence, or versatility, as a function of living organisms in much the same sense that maneuverability is a function of airplanes. One plane is more maneuverable than another because it has structures concerned with maneuverability which are superior to those of the other. The intelligence of organisms is likewise based upon their structures; but it also depends upon what happens to these structures during a lifetime.

The structure of greatest importance is the brain, for the brain that one is born with has much to do with how intelligent he can become. Human adjustment is at a high sym-

bolic level because man has a brain sufficiently complex to acquire and use symbols.

The brain is relatively small at birth and its size increases fourfold before maturity is attained. No new cells are added, but the growth of cells already present continues and their interconnections become increasingly complex. The growth of intelligence from birth to maturity is doubtless related to these developments. The growth of some brains is arrested in early life and feeble-mindedness results.

### The importance of stimulation

Another factor of importance for intelligent behavior is what happens to the individual, or how his brain is used. One could inherit a brain with high capacity for acquiring and retaining symbolic and other skills, yet live in a relatively nonstimulating, or impoverished environment. The brain would continue to grow, but the information fed into it would be relatively meagre and, as a result, versatility would be at a much lower level than it might otherwise have been.

The blind, the deaf, and especially the blind-deaf grow up to be feeble-minded unless steps are taken to circumvent their handicap and bring information to their brains. The deaf-blind Helen Keller would doubtless have had a low order of intelligence were it not for the fact that she was painstakingly taught, through her sense of touch, to know a great deal about the world, as well as acquire symbols with which she could communicate with others.

The point that we have been making — that intelligence is dependent upon learning ability and that it cannot develop in an environmental vacuum — may be further illustrated by a hypothetical experiment.

### A hypothetical experiment

Suppose that we separate identical twins at birth and bring them up in environments more widely different than in the cases of the identical twins reared apart that we have already discussed (pp. 72–73). One is reared, let us say, by foster parents of very low intelligence and in some isolated community with extremely poor educational opportunities and

a general intellectual impoverishment. The other is reared in the home of well-educated foster parents, where it is read to, sent to good schools, and given every opportunity to be stimulated intellectually and to acquire knowledge.<sup>3</sup> Being identical, these twins have identical brains, to begin with, and the inherent growth processes are the same in each.

We shall assume that, given average opportunities to learn, the intelligence of these twins would be average, i.e., that they began life with average brains. The only difference between them would be the environmental one already posited. Suppose now, that this environmental difference continued until the early teens and also that the intelligence of the twins was then measured by tests like those to be considered in this chapter.

There is no doubt whatever about the general outcome of such an experiment. The twin brought up in an impoverished intellectual environment would be below the other in its test performance, and below the level it might have attained if reared under average conditions. And the twin given superior opportunities would doubtless have a higher level of performance than it would have attained if reared under average conditions.

What might happen if the twins were now brought together and given good opportunities in a comparable environment? Would the one who was handicapped earlier, now catch up with the other? That is a question which we cannot answer with any degree of assurance. The level of intelligence of this twin would probably improve, but would it improve as much as it might have improved without the earlier environmental handicap? There is a good possibility that it would not. Early in life we *learn how to learn*, and each accomplishment prepares the way for others. There is a “snowball effect.” Early educational handicaps are not easily overcome.

For our example we took two individuals whose intelligence would normally have been average. If we had taken children whose brains were initially below average, the diversity produced by the difference in environments would not have been as great as that suggested. This is because the child given exceptionally good opportunities could not have responded normally to them. If, on the

other hand, we had taken twins with far better than average brains the difference between them might have been far greater than that suggested. The twin in the intellectually impoverished environment might have broken through the environmental barriers to some extent. But his brother would most likely have made such excellent use of his intellectually enriched environment as to have greatly increased the difference in their intelligence, especially as compared with the difference existing had they been potentially average. If our examples were far above average moreover, the early handicap of the environmentally impoverished twin might to a greater extent have been overcome when better opportunities occurred. The difference between the twins, if not eliminated, would in this event at least have been narrowed more than if they had possessed no better than average brains.

This discussion has served to point up the fact that our intelligence is a function of the brain we are born with, its growth to maturity, and how it is modified by what happens to us. Thus intelligence is not something we are born with. It develops and, at every stage of development, reflects the individual's interaction with his environment. At birth we may have a *capacity*, a *potentiality* for intellectual growth, but this cannot be realized except through learning.

One of our leading child psychologists has said that the growth of human intelligence "depends pre-eminently upon the acquisition of the verbal tools of problem solving."<sup>4</sup> It is indeed true that differences in the versatility of human beings are most evident with respect to such tools. They are of major significance in human adjustment and we shall now see that tests built around them provide our best measures of human intelligence.

## BEGINNING OF INTELLIGENCE TESTS

In 1896 a French psychologist named Binet, who had been studying psychological processes in school children, suggested the creation of special classes for those children who, because of low intelligence, were unable to progress as fast as others. Eight years later, Binet was asked to serve on a commission formed for the

express purpose of discovering which children in the public schools had insufficient intelligence to profit from the usual instruction. Obviously it would be impossible, without doing an injustice to many children, to segregate them on the basis of teachers' judgments: Teachers would almost surely have prejudices and be subjected to various influences from parents and others. They could not be relied upon to make objective judgments. What was needed was a set of objective tests, tests which would measure the intelligence of all children on a strictly comparable basis. Binet felt that a graded series of psychological tests could be devised which would indicate the level or degree of each child's intelligence.

### Development of the first "scale"

By experimenting with children who were making average progress in school, Binet and a collaborator named Simon discovered which of many attention, memory, discrimination, and other tests could be performed by average individuals. They devised a scale comprising thirty tests arranged from the simplest to the most complex. By applying the scale to individuals known to be feeble-minded, Binet and Simon were able to obtain norms for these. They found out, for example, how many tests in the average scale could be done by idiots and other individuals classified as feeble-minded.

By applying their intelligence test to school children, Binet and Simon attempted to discover each child's mental development. If a child of five did only the first nine tests in the scale, the tests performed by a normal three-year-old, it was obviously retarded about two years. If a school child failed to go beyond the first six tests, those passed by idiots, he was designated an idiot. As Binet and Simon put it, they wished "simply to show that it is possible to determine in a precise and truly scientific way the mental level of an intelligence, to compare the level with a normal level, and consequently to determine by how many years a child is retarded."<sup>5</sup>

### The Revised Binet-Simon tests

There were many defects in their original scale, hence Binet and Simon eventually devised improved scales in which an attempt

was made to eliminate all items which would require special schooling for their performance. Binet realized that, if the test were to measure *ability to acquire*, and not merely information, it must use items which any normal child, regardless of whether or not he had received training in special fields of knowledge, could be expected to perform. Moreover, the items of the new scale were arranged into age groupings.

The test items to be used at a particular age level were not decided upon in an arbitrary fashion. They were tried out at different age levels. For illustrative purposes, let us consider the items at age five: weight discrimination, copying a square, repeating a sentence of ten syllables, counting four pennies, and fitting together the halves of a divided triangle. Each of these items was included at this age level because the average five-year-old could do it.

More specifically, Binet and Simon proceeded somewhat as follows: An item was regarded as adequate for testing five-year-old intelligence if from about 60 to 75 per cent of children at this age were able to perform it accurately, if less than about 60 per cent of four-year-olds could do it correctly, and if it was mastered by more than 75 per cent of six-year-olds. Thus the item had to be too difficult for the age level below and too easy for the age level above, in order to be included at the intermediate level.

#### The concept of mental age

In line with their arrangement of the scale into age groupings, Binet and Simon developed the concept of *mental age*, or M.A. The child who could do the five-year tests, but who could not go on to the six-year level, was credited with a mental age of five years. The child of chronological age (C.A.) five who achieved an M.A. of five was, of course, regarded as having average or normal intelligence. However, the child with an M.A. of five might actually be ten years old (C.A., ten years). He would, of course, be extremely dull for his age. On the other hand, a child with an M.A. of five and a C.A. of three would be extremely bright. The concept of M.A., therefore, indicated the level of intelligence achieved, but it gave no indication of the brightness or dullness of the

individual concerned. A person is not regarded as bright unless we know that his level of performance is better than the level achieved by others of his own age. He is not thought to be dull unless his performance is below that of others of his own age.

#### The intelligence quotient

It was later suggested that an intelligence quotient (I.Q.), derived by dividing C.A. into M.A. and multiplying by 100 (to remove decimal places), would be much more meaningful than M.A. alone.<sup>6</sup> Such a quotient would show the rate with which M.A. was increasing in relation to C.A. In a child of average intelligence, whose M.A. equaled the C.A., the I.Q. would be 100, regardless of the actual age. A child of ten years whose M.A. was found to be 10 would have an I.Q. of  $10/10 \times 100$ , or 100. A child of ten years whose M.A. was 5 would have an I.Q. of  $5/10 \times 100$ , or 50. This child would be fifty I.Q. points below average. However, a child of ten years with an M.A. of 14 would have an I.Q. of  $140$  ( $14/10 \times 100$ ) and this would place him forty points above the average child of his own age.

#### Infant tests

The Binet-Simon tests extended down to the three-year level, as we have seen. A widely used American modification, to be discussed presently, goes down to two years. But there has been an insistent demand, especially from adoption agencies, for tests extending to the first few months of life. The desire to test intelligence at early age levels produced several baby tests beginning with one developed at Yale in the early twenties by Arnold Gesell. This and all later infant tests are alike in emphasizing sensory and motor development.<sup>7</sup>

We must report, however, that infant tests have failed to fulfill the hopes of those who would like to predict later intelligence while the individual is very young. One study after another has shown that infant performance is insignificantly correlated with that of later childhood.<sup>8</sup> What appears to be a bright baby may turn out to be average or even dull when tested years later.

Why have infant tests failed to predict later

intelligence? There are several possible reasons, but two are especially important. One reason is that infants are not very versatile anyway and there is not much to test. That is why all of the baby tests are alike, why they are all concerned predominantly with the same sensory and motor activities. The second reason for the failure of infant tests to predict later intelligence is that this differs significantly from infant intelligence. This point is emphasized by Dr. Nancy Bayley whose Berkeley Growth Study has involved repeated testing of the same individuals from the age of two months into adulthood. She says that "It may be a mistake to try to call any infant behavior before 6 months more characteristically 'mental' than motor."<sup>9</sup> Another psychologist who analyzed the Berkeley data statistically found evidence that three different functions were measured at different age levels. Although the three showed much overlapping, "sensory motor alertness" predominated during the first two years, "persistence" from the second to the fourth year, and "manipulation of symbols" thereafter.<sup>10</sup> The two reasons that we have given are of course interrelated. The only infant test that could be expected to predict later performance would be one with a great deal of symbolic content, but babies are not functioning at a symbolic level, at least sufficiently to provide items which differentiate them.

The tests which we now are about to describe begin at the earlier age levels, with several items that are predominantly sensory and motor. Then, at successively higher age levels, they increasingly use symbolic material.

### THE STANFORD-BINET TESTS

These tests, so named because they were devised by psychologists at Stanford University following lines laid down by Binet, have appeared in three editions. The first Stanford-Binet Intelligence Scale was devised in 1916 by Professor Lewis M. Terman. A more extensive scale, with two forms, was later developed with the collaboration of Professor Maud Merrill. This scale, which appeared in 1937, became the most extensively used device for testing the intelligence of children individually. It was translated into many languages and adapted in other ways for use

throughout the civilized world. Most of the I.Q.'s discussed in this chapter were derived by using either the L or M form of the 1937 revision. In 1960 a further revision appeared.<sup>11</sup>

#### The 1960 Stanford-Binet Scale

This revision incorporates the best items from the L and M forms of the earlier test and is thus designated the L-M form. By "best" items is meant those which have current value in differentiating various age groups. This was determined by analyzing the results obtained in administering the L and M forms to 4498 subjects ranging in age from 2½ to 18 years. One of the major bases for selection of any item was an increase in the per cent passing it as age (or mental age) increased.

Some typical materials for the L-M form are pictured in Figure 4.3. As was the case with earlier forms of this test, the items are used in accordance with a carefully standardized procedure. Very little is left to the tester's judgment. This is also true with respect to scoring.

In the L-M form, there are both yearly and half-yearly tests for ages two to five, with six items at each level. Passing an item adds one month of M.A. to the child's score. For years 5 to 14, however, there are six items at each yearly level, with each item carrying an M.A. weight of two months. There are also four adult tests, ranging from average to very superior. Here again, passing an item adds a specified number of months to the individual's M.A. score.

Although the exact details of mental tests must be reserved for those qualified to administer them, an idea of the nature of items at widely different age levels of the Stanford-Binet Intelligence Scale may be gained by examining the selection given.

#### *Items Illustrating the 1960 Revision (L-M Form) of the Stanford Binet Intelligence Scale*

##### Year II

1. Three-hole form board. (Places forms in holes.)
2. Delayed response. (Finds toy animal after it has been hidden.)
3. Identifying parts of the body. (Indicates named parts on doll.)

**4.3** Some of the Stanford-Binet Test Materials. Subject being tested is to name some of these items. Some are used in more complex tests, as when one is covered and the child is asked to recall what it is. The strictly verbal material used at higher age levels and including the vocabulary list is of course not evident here. (Photo by A. M. Love, Jr.)



4. Block-building: Tower. (Builds tower from model after demonstration.)
5. Picture vocabulary. (Names common objects while looking at pictures of them.)
6. Word combinations. (Spontaneous word combinations made by child during the session are noted.)
4. Arithmetical reasoning. (Standard arithmetical problems are solved.)
5. Proverbs. (Tells the meaning of given proverbs.)
6. Orientation: Direction. (The subject tells in what direction he would be going after specified turns.)

#### Year XI

1. Memory for designs. (Draws certain designs from memory.)
2. Verbal absurdities. (Tells what is foolish about given statements.)
3. Abstract words. (Tells what do we mean by?)
4. Memory for sentences. (Repeats what has been read.)
5. Problem situation. (Tells why people acted as they did in a story situation presented by the tester.)
6. Similarities. (Says in what way certain groups of objects are alike.)

#### Average adult

1. Vocabulary. (Defines a specified number of words from a standard list.)
2. Ingenuity. (Solves a reasoning test.)
3. Differences between abstract words. (Pairs of words are given and the subject tells how they differ in meaning.)

The reader should note, in passing, that this test utilizes language to a high degree. There are vocabulary tests at various levels in addition to that of the average adult; and, at every level, there are items involving the subject's understanding and use of words. It is not surprising, therefore, that this is designated a "verbal" test.

#### How a child is tested and scored

Those who administer the Stanford-Binet Intelligence Scale are instructed to win the child's confidence and attempt to overcome any evident nervousness and timidity. One way in which this may be accomplished with young children is to suggest that the tester and the child are playing a game. The tester also encourages the child by praising his performance. Such encouragement is given, whether the response is correct or incorrect.

The child is never told, "That is wrong." He is encouraged by such comments as, "That's very good, now we'll try the next one."

After the child is at his ease, the test is administered in accordance with established procedure. If the child is judged to be below normal (that is, mentally below others of his age) the test begins with items well below those designed for his actual C.A. level. Should the child appear average, however, the first items administered are those for children one year below his C.A. Take a child of nine years and two months, for example. If he appears to be approximately normal, he is given the items for year VIII. If he passes the six items at this level, he is next given those for year IX. Should he pass all of these, the child is next given the items for year X. Here, perhaps, he passes only four of the six tests. At the next level, year XI, he succeeds, shall we say, in doing two tests. Let us suppose, furthermore, that he does one test at the XII year level and fails all at the XIII year level. The test terminates at this point. The child's M.A. is then calculated as follows:

Year IX	All tests passed	108 (basal age)
Year X	Four tests passed	8
Year XI	Two tests passed	4
Year XII	One test passed	2
Year XIII	All tests failed	0
		<hr/> 122 months

His M.A. is thus 10 years and 2 months (or 10-2). Observe that the child is credited with all the months of mental age prior to the highest level at which he passes all items. This is called the basal age. In the present example, it is nine years, or 108 months. The child is then credited with an additional two months for each item passed between the basal age and the age level on which he fails all items.

If this child's I.Q. were determined by the conventional method (i.e., using the formula  $M.A. / C.A. \times 100$ ), it would approximate 111. With the 1960 revision, however, the conventional I.Q. is replaced by a *deviation I.Q.* In the present instance, this would have been 108.

Deviation I.Q.'s are standard scores. The reader is already to some degree familiar with

such scores. We discussed them in indicating how the status of an individual score in a group of scores may be evaluated (p. 62). The standard score, it may be recalled, takes into consideration both the deviation of the individual score from the mean of the distribution and also the standard deviation (sigma) of the distribution. The Statistical Appendix gives further details on the calculation of standard scores. A graphic representation of their meaning is also given.

On the basis of standardization, the mean I.Q. for the 1960 revision of the Stanford-Binet Intelligence Scale is 100 at each age level. The sigma is 16. On this basis, tables are provided from which, given a child's M.A. score and his C.A., one can read off his I.Q. We read from this table that the above child, with a C.A. of nine years and two months and an M.A. of 10-2, would be credited with a deviation I.Q. of 108. In most instances, the difference between conventional and deviation I.Q.'s is smaller than in our example. However, deviation I.Q.'s are preferred because, like other standard scores, they facilitate the statistical interpretation of test data.

#### The interpretation of Stanford-Binet I.Q.'s

Calculation of an I.Q. is not enough. The tester needs to examine the test record closely, making an inventory of the child's strong and weak functions. For diagnostic purposes, this analysis is often much more useful than the mere determination of an I.Q. In fact two individuals may have the same I.Q. and yet differ a great deal in their intellectual abilities.

An I.Q., however it is measured or scored, is not, and should not be construed as, an index of native ability, or what has often been referred to in popular parlance as "raw intelligence." It is a comparative index, showing how a particular child performs as compared with others of the same chronological age. An I.Q. of 100 means only that the child achieves the mean performance of his age group. An I.Q. significantly lower than 100 signifies that the child's performance is correspondingly poorer than that of his age group; an I.Q. significantly above 100,



that his performance is correspondingly better than that of his age group. This presupposes, of course, that the children compared have had basically similar opportunities to develop their intellectual abilities. More will be said about the comparative nature of I.Q.'s when we discuss group differences and also the question of whether these differences indicate anything about native capacity.

It is customary to refer to levels of intelligence in terms of I.Q. ranges, as indicated in Table 4.1. But this is only a rough frame of reference, for other things than I.Q.'s enter into such designations as "idiot," "imbecile," and the like. The terms "gifted" and "genius" are often used to categorize upper levels of test performance. Terman spoke of individuals with I.Q.'s higher than 130 as gifted. It is sometimes said that those of 140 I.Q. and above are at the "potential genius" level of intelligence. But, here again, other factors than I.Q. usually enter such considerations. This will be evident when the mentally gifted are discussed.

Table 4.1. Levels of Intelligence in Terms of Stanford-Binet I.Q. Ranges

	I.Q. Range
Idiot	Below 25
Imbecile	25-50
Moron	50-70
Borderline defective	70-80
Low normal	80-90
Normal or average	90-110
High average	110-120
Superior	120-140
Very superior	Above 140

The Stanford-Binet Scales are referred to as *individual* tests because they must be administered to one person at a time. In this respect they differ from *group* tests, to be considered later in this chapter. For reasons already cited, these tests are also designated as *verbal*. Exceptions to their predominantly verbal nature are items calling for such performances as placing forms in a form board and stringing beads. But these are used only at the early age levels. Those which use such nonverbal items exclusively are known as *performance* tests.

There are many individual tests, both verbal and performance, but the tests that we shall now consider are of particular interest to us here as illustrating the use of percentiles instead of M.A.'s and I.Q.'s. Moreover, one of these tests, like the 1960 Stanford-Binet, also uses a deviation I.Q.

## THE WECHSLER TESTS

These tests, developed and standardized under the direction of Dr. David Wechsler of Bellevue Psychiatric Hospital, began with a scale designed to test the intelligence of adults. This, the Wechsler-Bellevue intelligence scale, was recently superseded by an improved test, the Wechsler Adult Intelligence Scale (WAIS).<sup>12</sup> A separately standardized test known as the Wechsler Intelligence Scale for Children (WISC) is similar to the adult tests in that it has both verbal and performance items and yields separate scores for these.<sup>13</sup> This test is also similar to the adult scales in that the items are arranged in order of difficulty without reference to age. Thus, although the scale covers the years from five to fifteen, there are no five-year tests, six-year tests, and so on. The child starts on the simpler items of a series and goes to items of increasing difficulty until his limit for that series is reached. He then goes to other series. His accomplishment is evaluated, not in M.A. units, but in terms of how it compares with that of others of his own age. One such evaluation, as suggested above, uses the percentile standing of the individual with respect to his age group. Another way in which the individual score is evaluated is to note by how many standard deviation units it exceeds or falls below the average. If the reader will examine the normal distribution curve (p. 539) in the Statistical Appendix he will see how percentile and standard scores are interrelated.

Performance on adult intelligence tests is seldom evaluated in terms of I.Q. Percentiles or standard scores are most frequently used. The WISC uses the same method of interpretation with children as with adults. Nevertheless it is possible to calculate deviation I.Q.'s such as those used in the 1960 Revision of the Stanford-Binet Intelligence Scale (p. 88).



**4.4** The Kohs Block Design Test as Used in the Wechsler Scales. The subject is required to arrange the blocks to match sample patterns of which that illustrated is the most complex.

The verbal items in the Wechsler scales test general information, comprehension, arithmetic, memory, and vocabulary. Most of them are similar, in essential respects, with the verbal items in other tests, including the Stanford-Binet. The performance items include such relatively complex tasks as arranging blocks to match a sample design (Figure 4.4) and placing pictures into a meaningful sequence (Figure 4.5). These complex performance items require a high level of perceptual and reasoning ability and they provide a link between tests that are predominantly verbal and those that are predominantly motor, like certain simpler performance tests considered later in this chapter.

It is interesting to note that, when groups

of children are given both the WISC and the Stanford-Binet, the correlations between scores on the two tests range from .60 to .90. The verbal scale of WISC correlates more highly with Stanford-Binet scores than does the performance scale. This is not surprising, since the latter test places so much emphasis upon verbal skills.<sup>14</sup>

## PERFORMANCE TESTS OF INTELLIGENCE

Strictly speaking, of course, all intelligence tests are measures of performance. Nevertheless, the term *performance* is customarily applied to tests which require a minimal understanding and use of language. They are *nonverbal* in contrast with predominantly *verbal* tests like the Stanford-Binet.

Our discussion of infant tests revealed that these are wholly of a performance nature. One will recall that the Stanford-Binet test at lower age levels includes performance items and that 50 per cent of the items on the Wechsler scales (WAIS and WISC) are likewise nonverbal. There are, however, many single performance tests for which age-norms are available. Some of these are illustrated in Figure 4.6. Batteries of such tests are sometimes incorporated into broader tests (like the WAIS and WISC) and standardized as a battery.

Performance tests may provide a measure of fundamental psychological processes like reasoning and perceiving relationships, yet without depending upon particular cultural or educational opportunities. They enable us to estimate the intelligence of individuals: (1) who are too young to have used a language, as in the case of infant tests; (2) who are illiterate through lack of educational opportunity or feeble-mindedness; and (3) who speak only a foreign tongue. They have been used in numerous places where tests of the Stanford-Binet variety would be useless.

The correlation of performance test scores with scores on verbal tests like the Stanford-Binet is, as one might expect, not as high as the correlation between other verbal tests and the Stanford-Binet. We indicated earlier, for example, that the performance scale of the WISC correlates about .60 with the Stanford-Binet, whereas the verbal scale correlates

A



B



C



D



E



F



**4.5 A Picture Arrangement Test.** This is not one of the Wechsler-Bellevue items, but it is similar to those in the picture arrangement section of that test. The subject is required to arrange the items in the proper sequence. The correct sequence for these pictures is given on p. 490. (Drawing by Alain, reproduced by permission. Copyright 1943 The New Yorker Magazine, Inc.)

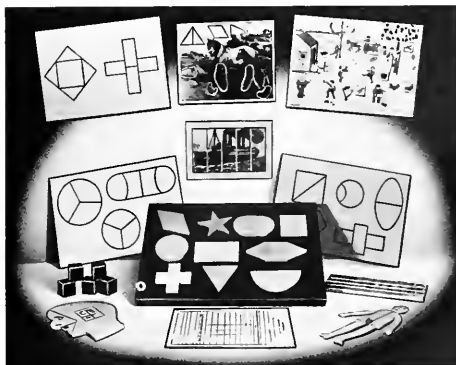
about .90. Generally speaking, psychologists prefer to use verbal tests when these are applicable, but performance tests are useful when, for the reasons given above, one encounters linguistic handicaps.

#### GROUP TESTS

All of the tests which we have so far described are referred to as *individual tests* be-

cause they involve the testing of one person at a time. But the administration and scoring of the individual tests is usually laborious and time-consuming. Administration of the Stanford-Binet test is a case in point. It requires a highly trained tester to spend one hour or more with each individual. Added to this time is that required for evaluating each response, in relation to carefully standardized and specified norms, calculating the M.A., and

**4.6 Some Typical Performance Tests.** These are used in the Pintner-Paterson Performance test. A similar monnikin test (lower right) and profile test (lower left) are also used in the performance scales of the WAIS and WISC. In these tests the parts are presented in a scattered array and the individual puts them together. The sections of the formboard, the mare and fool picture, the ship picture, and the picture completion test (upper right) are removed before the test begins and the child is required to place them in their proper positions. Four of the cubes are tapped in a certain order and the child is asked to imitate this. (Courtesy C. H. Stoelting Co.)



finding the I.Q. In many practical situations it is necessary to test large numbers of individuals quickly and without such highly specialized personnel as most individual tests require for their administration and scoring. It is then that group tests are indispensable.

### Applications of group tests

The need for group tests of intelligence was especially pressing in 1917–1918 when 1,750,000 draftees were tested and more so in the years from 1941–1945 when over 10,000,000 were tested.

Prior to 1917, psychologists had begun to devise group tests of intelligence, but these had not been published. When psychologists were asked to investigate the intelligence of draftees, they formed a committee which considered all earlier intelligence tests and finally developed two, a verbal and a nonverbal, which could very quickly be administered to large groups, and just as readily scored. These were known, respectively, as the *Army Alpha* and *Army Beta* tests.<sup>15</sup> Principles underlying selection of items for the tests were similar to those followed in the development of the Stanford-Binet Test. That is to say, the items were such as to measure those psychological processes which are regarded as important aspects of intelligence, the tests were intrinsically interesting, and their performance did not require special schooling. Administration and scoring of the tests was quickly mastered, hence a long period of training and practical experience such as that required for administration and scoring of tests like the Stanford-Binet was not required. During the last war, as a matter of fact, the somewhat comparable Army General Classification Tests (AGCT) were machine scored. A similar test, known as the Armed Forces Qualification Test (AFQT), has been used more recently to screen recruits for the Armed Services.<sup>16</sup>

The value of group intelligence tests became so apparent, as a result of the army experience, that many other group tests, designed for school and college use, soon appeared.

The most recently developed group tests, the *Lorge-Thorndike Intelligence Tests*, were standardized on 136,000 children from kindergarten through high school.<sup>17</sup> The children were sampled so as to provide proportional representation of the various socio-economic

levels in the United States. A few items similar to those in this test appear in Figure 4.7. It includes verbal and nonverbal items. Scoring provides such information as the individual's deviation I.Q. and his percentile rank.

### Disadvantages of group tests

The chief disadvantage of group tests as compared with individual tests is that those who administer the former cannot be sure that each individual is at his ease, that he is in a fit condition to be taking the test at that time, that he is trying to do his best, or that he is following instructions properly. With respect to the last point, consider the following example: A child with a Stanford-Binet I.Q. of over 130 took a group test and his I.Q. on this was 108. I.Q.'s determined with different tests often differ, but this was not the chief reason for the discrepancy in this case. The teacher giving the test had emphasized that the children must be *sure* to blacken the space between the lines which indicate the correct answers, as in Figure 4.7. This child, an especially conscientious one, was observed to spend a lot of time blackening the spaces, and even going back to make sure that he had done a good job. The result was wasted time, fewer items marked than should have been marked in the test's time limit, and an I.Q. which did not represent the level of the child's intelligence. When obvious instances of improper following of instructions are observed, as in the present case, the I.Q. can be discounted. However, when hundreds take a test at the same time, there are bound to be some such uncontrolled aspects as we have indicated. In short, while they are indispensable in many practical situations, group tests cannot be as well controlled as individual tests.

### Group tests in education

When group intelligence tests are used in school and college, they serve two main purposes. In the first place, they may be used to select those who will be admitted. The correlation of about .60 between scores on such tests and college marks suggests their predictive value. In the second place, they may be used for guidance purposes. Most students take such

## VERBAL BATTERY

**VOCABULARY** — Choose the word that has the same meaning or most nearly the same meaning as the word in dark type at the beginning of the line.

**benevolent** A lordly B stingy C kindly D poor E evil

A	B	C	D	E
:	:	:	:	:
:	:	:	:	:

**hyperbola** A stupidity B horizon C criticism D position E curve

A	B	C	D	E
:	:	:	:	:
:	:	:	:	:

**SENTENCE COMPLETION** — Choose the word that will make the best, the truest, and the most sensible complete sentence.

**Adversity makes a man . . . , not rich.**

A wealthy B joyous C holy D wicked E wise

A	B	C	D	E
:	:	:	:	:
:	:	:	:	:

**Men are more apt to be mistaken in their generalizations than in their particular . . .**

A retractions B observations C intuitions D inferences E presumptions

A	B	C	D	E
:	:	:	:	:
:	:	:	:	:

**ANALOGIES** — Find the word that goes with the third word in the same way as the second word goes with the first word

**harmony** → **discord** :: **agreement** →

A dissonance B incongruity C antagonism D dissension E divergence

A	B	C	D	E
:	:	:	:	:
:	:	:	:	:

**irrelevant** → **extraneous** :: **pertinent** →

A congruous B constitutional C prerequisite D intrinsic E comprehensive

A	B	C	D	E
:	:	:	:	:
:	:	:	:	:

## NON-VERBAL BATTERY

**NUMBER SERIES** — The numbers at the left are in a certain order. Find the number at right that should come next.

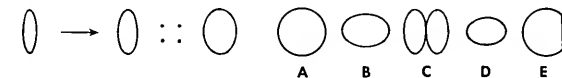
159 53 51 17 15 5 A 3 B 6 C 9 D 12 E 18

A	B	C	D	E
:	:	:	:	:
:	:	:	:	:

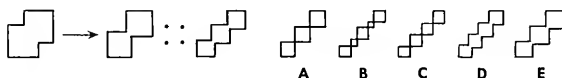
64 16 48 12 36 9 A  $2\frac{1}{4}$  B  $6\frac{1}{4}$  C  $9\frac{1}{4}$  D 27 E 81

A	B	C	D	E
:	:	:	:	:
:	:	:	:	:

**FIGURE ANALOGIES** — The first two drawings go together in a certain way. Find the drawing of the right that goes with the third drawing in the same way that the second goes with the first.



A	B	C	D	E
:	:	:	:	:
:	:	:	:	:



A	B	C	D	E
:	:	:	:	:
:	:	:	:	:

**4.7** Items illustrative of those in the **Large-Thorndike Intelligence Tests**. These items are not in the actual test but are used to illustrate its nature. (Courtesy Irving Lorge and Robert Thorndike and Houghton Mifflin Company.)



view the childhood accomplishments of a few of them.

John Stuart Mill, the great English philosopher, logician, and economist began to study Greek at three, read Plato at seven, studied Latin, geometry, and algebra at eight, and at twelve was studying philosophy. At the age of six years he began a history of Rome.<sup>20</sup>

Charles Dickens, before the age of seven was reading such books as *The Vicar of Wakefield*, *Don Quixote*, and *Robinson Crusoe*. He also wrote a tragedy before he was seven.<sup>21</sup>

At the age of eight, Goethe was preparing for the university. During his tenth year he wrote what are said to be "clever Latin essays." At sixteen he not only read five languages in addition to German, but he was reading the classics in them. He studied law, philosophy, and literature. At twenty-three he published his first important work. In adult life he excelled in the writing of literature, but he was also a scientist and statesman.<sup>22</sup> Similar feats could be cited for most of the three hundred geniuses of historical importance whose careers have been studied by psychologists.

Many of our great present-day scientists and writers also demonstrated their brightness at an early age. Others failed to exhibit any great childhood precocity. Even Einstein was no infant prodigy. At nine, according to a biographer, Albert was an "amiable dreamer," and everything he said was expressed only after careful consideration.<sup>23</sup> The potential genius of Einstein may at that time have been veiled by his reticence. It is quite likely, on the other hand, that intelligence tests, had they been available in his childhood, would have then revealed Einstein's very high level of intelligence.

Table 4.2 cites the estimated I.Q.'s of some famous persons. Estimations were based upon various criteria, including comparison of their childhood accomplishments with those of children of known I.Q. These individuals undoubtedly inherited superior brains, but they also (see footnote) enjoyed unusual opportunities to learn.

We will now see how intelligence tests can be used to discover potential geniuses and how children so discovered can be encouraged to fulfill their evident promise of future accomplishment.

Table 4.2. Estimated I.Q.'s of Some Famous People\*

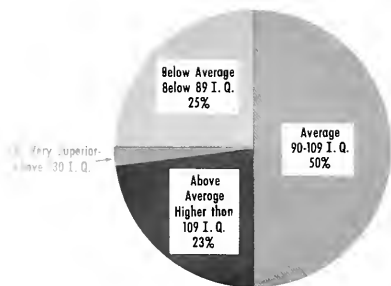
Sir Francis Galton	200
John Stuart Mill	190
Johann W. von Goethe	185
Samuel Taylor Coleridge	175
Voltaire	170
Alexander Pope	160
William Pitt	160
Lord Tennyson	155
Sir Walter Scott	150
Mozart	150
Longfellow	150
Victor Hugo	150
Lord Byron	150
Thomas Jefferson	145
John Milton	145
Benjamin Franklin	145
Disraeli	145
Francis Bacon	145
James Watt	140
Rubens	140
Alexander Dumas	140
Napoleon Bonaparte	135
Charles Darwin	135
John Calvin	135
Edmund Burke	135

#### Terman's gifted children

In 1921 Terman began a study of gifted children that is still in progress. Over 1000 children with I.Q.'s ranging from 130 to 200 were located. An I.Q. this high is found in only 2 per cent of the population (see Figure 4.8). The average I.Q. in Terman's group was 150. Eighty of the children had I.Q.'s of 170 or higher. Most of these gifted individuals, including some added later, have been interviewed at intervals over the years.† Their careers are also being studied to see whether

\* Selected from Cox, C. M. *The Early Mental Traits of Three Hundred Geniuses*. Stanford University Press, 1926. The childhood of a number of these has been reported in some detail by McCurdy, who shows that each had an unusually high degree of attention focused upon him as a child. This attention, upon a "groundwork of inherited ability," undoubtedly contributed to their genius. (See McCurdy, H. S. "The Childhood Pattern of Genius." *J. Elisha Mitchell Scientific Society*, 73, No. 2, 1957, pp. 448-462.)

† They are often referred to as "Termites"!



**4.8 The Gifted Are Relatively Few.** This graph based upon Wechsler I.Q.'s shows that only about 2 per cent of the population is in the gifted class. (Data from Wechsler, D., *The Appraisal of Adult Intelligence*, 4th ed. Williams and Wilkins, 1958, p. 42.)

the promise of youth is being fulfilled. The most recent survey of the group was reported in 1959.<sup>24</sup>

It is of interest to note, in the first place, that the early level of intelligence was retained, thus indicating the predictive value of the initial I.Q.'s. When tested again at an average age of 30 years, for example, the group's performance was such as to place it in the upper 2 per cent of the population in intelligence. In 1951-52 an especially difficult Concept Mastery Test designed to reach into "the stratosphere of adult intelligence" was given to over 1,000 of the original group. This indicated that the intelligence of the gifted group at that time was as much above the general adult level as it was above the general child level initially.

With respect to educational performance the following facts are of particular interest: 70 per cent of the group graduated from college. Of these, about one-third received honors. About two thirds of the college group went to graduate school. Dr. Terman points out that the educational record would have been better but for the fact that many reached college age during the depression. It is interesting to observe that 40 per cent of the men and 20 per cent of the women earned half or more of their undergraduate expenses. Among

800 gifted males, there were 78 Ph.D. or equivalent degrees, 48 medical degrees, and 85 law degrees. There were 74 college teachers, 51 of them engaged in research in the basic sciences or engineering. Over 100 were engineers, some of whom did applied research. Attention is called to the fact that "Nearly all of these numbers are from 10 to 20 or 30 times as large as would be found for 800 men of corresponding age picked at random in the general population, and are sufficient answer to those who belittle the significance of I.Q. differences."<sup>25</sup>

In general, this group had more than eight times its proportional share of positions in professional fields. Moreover, a large proportion of the men had distinguished war records. One became director of a major laboratory devoted to applications of atomic energy. Another headed a major project for the Office of Strategic Services (OSS). Still another was co-director, during the war, of a large-scale investigation of the physiological, biochemical and psychological effects of semistarvation.

The number of books and articles written so far by the men of Terman's group has been prodigious. According to a 1954 report, these men, at an average age of 40, had published 67 books (21 fiction), 1,400 scientific, technical, and professional articles, over 200 short stories, novelettes, and plays; and 236 miscellaneous articles. In addition, journalists of the group authored hundreds of news stories, columns, and editorials. The group also wrote innumerable radio and TV scripts and received 150 patents for their inventions.

Although most of the gifted women became housewives or entered nonprofessional fields some achieved notable public distinction. For example, one became a talented actress and playwright and another a composer and a concert pianist.

It is to be expected that such a large group will include some failures. Quite a few did well through high school, but were not interested in going to college. Some could not afford to go. Others went to college but lost interest. One girl purposely "flunked out" so that she could do something more to her liking.

The average physical and mental health, character, personality, and marriage adjustment of Terman's gifted group has remained at



or above the average of the general population. There is thus no ground for the commonly held view that brightness is offset by poor health and poor personal adjustment.

### The "Quiz Kids"

A large number of children with amazing erudition have been paraded before radio and television audiences. What happens to these child wonders? Do they "fizzle out" when they grow up or do they become outstanding adults? A follow-up study of children who appeared three or four times on radio and TV quiz programs reveals that they are still outstanding. According to a report on ten girls and four boys already in fulltime occupations, their average salary was \$5,000 a year. One was making \$20,000. The group included an actress, a concert musician, an organic chemist, a reporter, and a rewrite man. One of the boys got his Ph.D. at 22 and, at last report, was engaged in research. It is also reported that these young geniuses are all healthy and that they find life enjoyable. "They read a wide selection of novels, they play chess, go to concerts and the theatre, play music, dance, golf, swim, ride, hike, and travel."<sup>26</sup>

### Education of the gifted

Children with exceptionally high intelligence are often a problem to their parents, to their teachers, and to their other associates, unless sorted out and given opportunities to use their abilities.

Teachers without special training are not always good at recognizing superior intelligence. Here is a case in point. A Negro girl with an I.Q. of 200 was rated lower in intelligence by her teacher than a child whose I.Q. turned out to be 100.

Inability of the teacher to recognize genius in her pupils sometimes leads her to report as "trouble-making" what, for the gifted child far more advanced than she is in intelligence, is only natural. According to the late Dr. Leta Stetter Hollingworth, herself mentally gifted and a leader in education for the gifted, "Too many children of I.Q. 170 are being taught by teachers of I.Q. 120." She illustrates some of the difficulties by citing a conversation with a 10-year-old boy of I.Q. 165 — a boy referred to

her as a school problem: without interest in school, impudent, and a liar.

What seems to be your main problem in school?

Several of them.

Name one.

Well, I will name the teachers. Oh, boy! It is bad enough when the pupils make mistakes, but when the teachers make mistakes, oh, boy!

Mention a few mistakes the teachers made.

For instance, I was sitting in 5A and the teacher was teaching 5B. She was telling those children that the Germans discovered printing, that Gutenberg was the first discoverer of it, mind you. After a few minutes I couldn't stand it. I am not supposed to recite in that class, you see, but I got up. I said, "No; the Chinese invented, not discovered printing, before the time of Gutenberg — while the Germans were still barbarians."

Then the teacher said, "Sit down. You are entirely too fresh." Later on, she gave me a raking-over before the whole class. Oh, boy! What teaching. . .

"Ned, that teacher is foolish, but one of the very first things to learn in the world is to suffer fools gladly." The child was so filled with resentment that he heard only the word "suffer."

"Yes, that's it. That's what I say! Make 'em suffer. Roll a rock on 'em."

Before we finished the conversation, Ned was straightened out on the subject of who was to do the suffering. He agreed to do it himself.<sup>27</sup>

In a language art class, this was the experience of a gifted ten-year-old, Paula:<sup>28</sup>

Miss Jones was showing a colored picture. . .

"What do you see?" she asked.

Some answered, "An Arab."

"Why do you think he is an Arab?"

"Because of his clothes."

"What about his skin and complexion?"

"It's dark," several children said.

"Yes, you can recognize an Arab by his dark skin." Paula's hand went up but she received no recognition.

"But Miss Jones, I saw an —"



**4.9 Gifted Grade School Children Do High School Work.** These youngsters, whose I.Q.'s average 166, are reading in a college library where they are enrolled in a special advanced program in high school English, mathematics and science. They do most of their mature work in private study. (Photo by Cravens, *Life*, © Time, Inc.)

Miss Jones, ignoring Paula's attempt to comment, went on. "You can also tell he's an Arab by his dirty clothes."

"But," Paula persisted, "All Arabs are not dirty . . . I saw. . . ."

"Paula, will you speak when you are spoken to. Now class, another way you can recognize an Arab is by his straight black hair. He. . . ."

"But, Miss Jones," Paula interrupted, "I saw blond Arabs when I was travelling in Syria and the near East. They. . . ."

"I told you to speak when you are spoken to. You have interrupted me three times. This time I am going to send you to the office."

One can readily see that children like this might give up the struggle or get into many difficulties, perhaps drift into delinquency, unless treated by parents, teachers, and others

with due regard to their intelligence.

The highly gifted children in Figure 4.9 are receiving special instruction in keeping with their intelligence. Gifted children do not differ in appearance from most children in school. Without intelligence tests, many would not have been thought as intelligent as they really are.

#### MENTAL RETARDATION

Let us now turn to individuals at the lower end of the distribution, those referred to as retarded or feeble-minded. Many of these start their lives with a defective brain. They can therefore get relatively little from even the best of environments. In Figure 4.10, for example, are three such extreme types of feeble-mindedness.

The *microcephalic* has a very small brain.



**4.10 Some Clinical Types of Feeble-mindedness.** Left: microcephalic (offer Wollin). Center: hydrocephalic (after Tredgold). Right: mongolian (after Tredgold).

with the cerebrum very inadequately developed. This disorder occurs in both sexes. The microcephalic's brain, instead of developing in the normal way until a complete cerebrum is present, is diverted from the normal course or stopped at an early stage. As yet no one can say why this happens. The process of brain development is so complex that some slip-ups are perhaps to be expected. The disorder is apparently not inherited. Microcephalics are usually idiots (I.Q. below 25) and little can be done to educate them.

*Hydrocephalics* have an unusually large head, and usually with the peculiar inverted pear shape of the individual of our illustration. Early in development, for some unknown reason, the cerebrospinal fluid which fills the cavities of the brain and spinal cord accumulates in excess amounts, thus forcing the skull, which is plastic at early ages, into the shape indicated. This in itself would not be so serious if the brain were not damaged in the process. Brain cells are destroyed by pressure within the cranium and the individual's intelligence suffers accordingly. Quite frequently the head is so large that the hydrocephalic is bedridden. Depending upon the seriousness of the brain damage, his intelligence may range from idiocy to the moron level (50–70 I.Q.). In some cases the excess fluid may be drained off, but this is a temporary expedient. An

operation which diverts the excess fluid to a place in the body where it can be absorbed has apparently helped some cases.<sup>29</sup>

*Mongolianism*, so named because of a superficial resemblance to mongolian features, seems to come from disturbed metabolism originating in glandular defects. Post mortem examination of mongolians has revealed pituitary and other glandular deficiencies as well as retarded brain development. The latter is perhaps a reflection of disturbed metabolism in prenatal life. Efforts to discover why some children become mongolians have so far failed to reveal very much beyond the fact that this disorder occurs most frequently among children born relatively late in the mother's reproductive life. This suggests that mothers who are nearing the menopause may in certain cases provide an inadequate prenatal environment for their offspring.<sup>30</sup>

Most mongolians are at the imbecile level (I.Q. 25–50) but some are morons. Although nothing can be done to correct their basic deficiency, some of them may be taught to carry out relatively simple tasks.

Feeble-mindedness is sometimes caused by underactivity of the thyroid gland (hypothyroidism). It results from a deficiency of thyroxin, the hormone from the thyroid gland. If this condition is present from birth and if it is sufficiently severe, the individual has a

disorder known as *cretinism*. The cretin is characteristically dwarfed in appearance, overweight, pot-bellied and lethargic. His intelligence usually does not go beyond the imbecile level (I.Q. 50). But if this disorder is diagnosed sufficiently early and thyroxin is regularly administered, the child grows normally, both mentally and physically, as suggested by the case pictured in Figure 4.11. A thyroid deficiency may be insufficient to produce the typical picture of cretinism or may develop after infancy, yet still handicap the individual mentally. Here is a case which illustrates this fact.<sup>31</sup>

It is the case of an allegedly feeble-minded boy, who, at the age of twelve, had a mental age comparable to that of a child of eight. The boy's intelligence quotient (I.Q.) — the ratio of his performance to the average for his actual age — was 67, as compared with the norm of 100. When he took an intelligence test for the first time, he was stunted in physical growth and had been leading a very quiet life at home, where there had been no systematic attempt, for

several years, to stimulate his mental development. He was then taken to an expert diagnostician who made practically all the tests of metabolism known at that time to medical science. The boy was prescribed a special diet, given thyroid treatment, and at the same time placed in the hands of a trained teacher. Within two years he had grown considerably more than could have been expected without medical treatment and the soundness of his physical condition had vastly improved. He was tested again, this time at the age of fourteen, when his mental age was twelve, and his intelligence quotient was 86. How much of his improvement was ascribable to medical treatment is uncertain, but the boy was able to meet new problem situations which he had never solved before, demonstrating that his mental development was not the consequence of mechanical drill.

A possible interpretation of this case is that the thyroid defect, perhaps through the lethargy that goes with it, prevented the child from learning as much as children of his age, but of normal health, are able to learn. When

**4.11 Cretinism Before and After Thyroid Treatment.** The typical child is dwarfed, pot-bellied, and idiotic. If treatment is administered early, the child grows normally both mentally and physically. (Wide World Photos.)



his defect was corrected, his motivation became better. With a teacher provided to guide his learning, he was able to come closer to the performance norms for children having normal health and opportunities to learn.

Another form of mental retardation with a known cause and about which something can be done is *phenylpyruvic* feeble-mindedness. This mental retardation is a reflection of defective biochemistry. Most proteins contain an amino acid known as *phenylalanine*. The normal liver provides an enzyme which changes phenylalanine to another substance used by the body for energy. In cases of phenylpyruvic feeble-mindedness, however, this important liver enzyme is missing or non-effective. Consequently phenylpyruvic acid accumulates in the body and, among other things, interferes with brain functioning. One outstanding symptom is mental sluggishness. This disorder, estimated to afflict more than 6,000 of our feeble-minded, is diagnosed by testing urine for the presence of phenylpyruvic acid. Some success in correcting it is being achieved by removing phenylalanine from the diet. This therapy, which is very difficult to accomplish, has led to marked gains in alertness and in mental test performance, especially when started at an early age.<sup>32</sup>

In most cases of feeble-mindedness there is no known cause and there are no general physical abnormalities like those found in cretinism and other clinical types of feeble-mindedness. These cases, however, tend to run in families and it is not uncommon to have parents, children, and even grandchildren in the same institution (see Figure 3.19, p. 70). Where this occurs, the feeble-mindedness is clearly inherited. What is inherited in such cases is a defective brain or some biochemical defect which interferes with normal brain functions. Most of these individuals are morons (I.Q. 50-70). The following example is more or less typical of moron intelligence. It also illustrates what may be accomplished with appropriate educational procedures.<sup>33</sup>

Donald Noname . . . was a young man of twenty in an institution for the feeble-minded, the Training School at Vineland, New Jersey. Here Donald was being educated along the lines in which he could most easily advance. He was a handsome chap with a pleasant

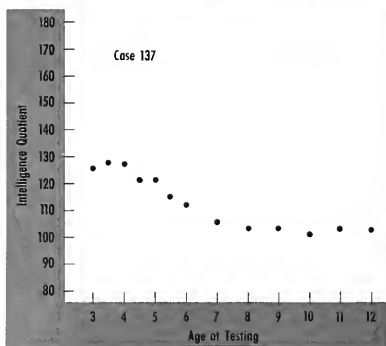
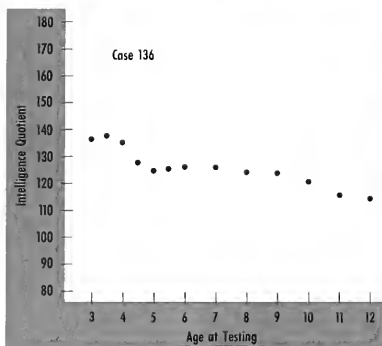
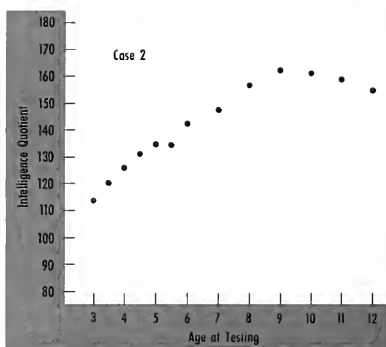
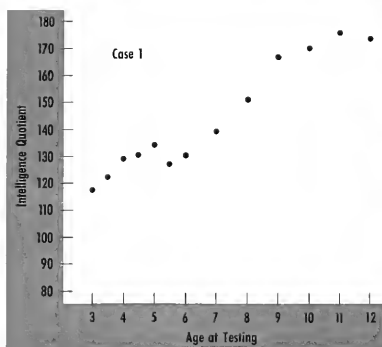
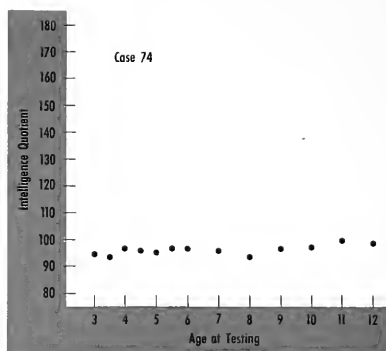
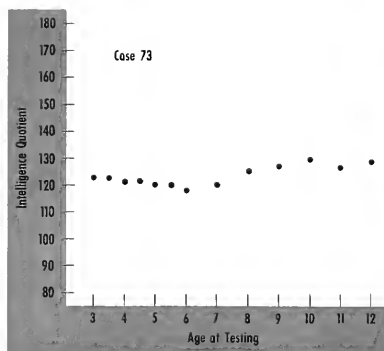
face, an alert manner, and but little awkwardness. He was an excellent farm hand and especially apt in handling farm machinery. One of his teachers called him "the finest industrial worker in the school." He had learned to play the bass horn well in the school band. His education in public school had progressed to the level of the first grade but there he stuck for four years. After five years of good instruction at Vineland with more personal attention than he would ever have got in public school, he was still at the first-grade level. At the age of fifteen he did not do quite so well on intelligence tests as the average ten-year-old, and, curiously enough, in school work he was still back below the seven-year level. He could not put the words, *girl*, *river* and *ball* together into a single unitary sentence. He could not define words like *charity* or *justice*. Given money he could not make correct change. Conversation with Donald soon broke down the first impression of his intellectual competence. He had a poverty of ideas, a lack of originality, a very limited stock of general information, only a vague comprehension of abstract relationships.

At last report, Donald was working for a family which took care of him, but expected no intellectual brilliance from him.

If a child's I.Q. is lower than that of the least successful children in the school system, we can keep him from going through the regular educational channels, where he will fall farther and farther behind his schoolmates. Many school systems provide so-called "opportunity classes" where special attention is given the mentally backward child. He can go farther this way than in the regular classes — without being made to feel inferior and without detracting from the attention other children should receive from the teacher. Moreover, there can be an increasing emphasis, as the child gets older, on practical things that he can learn to do instead of increasing emphasis on symbolic activities that are beyond him.

Those children who are too low mentally to profit from any regular schooling are usually placed in institutions where, with others of their kind, they can be reasonably well adjusted.<sup>34</sup>

Some of the higher-grade feeble-minded,



**4.12 I.Q. Changes Observed in Tests Given at Yearly Periods.** The curves are smoothed to indicate trends. These six cases have been selected from 140 in the Fels research. (Sontag, L. W., C. T. Baker, and V. L. Nelson, "Mental Growth and Personality Development: A Longitudinal Study," *Monographs of the Society for Research in Child Development*, 1958, 23, No. 2.)

like Donald Nonym, make useful citizens if properly trained. Most institutions for the feeble-minded train their higher-grade inmates to do useful work around the institution and, in some instances, to work on farms or do housework in homes where they are placed and supervised.

### INDIVIDUAL DIFFERENCES IN MENTAL GROWTH

Generally speaking, children who are very bright continue to be bright and children who are very dull continue to be dull. But what about the children in between these extremes? Does their I.Q. remain constant? On two tests given within a year or so of each other, the I.Q. usually changes very little if at all. That is to say, a child who has an M.A. of 6 at six years usually has an M.A. of 7 at seven years, which gives him an I.Q. of 100 at six and an I.Q. of 100 at seven. But as the years between tests increase, the I.Q. may undergo more or less change. In some children, the I.Q. fluctuates without any evident upward or downward trend while in others it gets larger or smaller with increasing age. The cases in Figure 4.12 illustrate this fact.

When changes in I.Q. do occur, we may well ask what causes them. Some improvements may be due to repeated tests, making a child "test wise." Some fluctuations may result from the use of different tests at different age levels. Some may be due to administration of a test by different testers at different age levels. These may be factors when the same children are tested repeatedly from infancy until later childhood or adolescence. However, they do not account for all the changes which occur. Two major *longitudinal*\* studies of mental growth are in progress, one at the University of California at Berkeley<sup>35</sup> and the other at Antioch College in Ohio.<sup>36</sup> The first of these, known as the *Berkeley Growth Study*, has followed the development of the same 61 individuals from the age of two months on into adulthood.

\* This general procedure is contrasted with *cross-sectional* studies which, instead of following the same individuals from one age level to another, test different groups at each age level.

At the last report the subjects of the study were 25 years old. The other longitudinal study, carried on at the Fels Institute for the Study of Human Development at Antioch College, has reported developmental information on 200 individuals studied from the time of birth until their twelfth year. The cases in Figure 4.12 were from this study.

The findings of the Berkeley and Fels studies are in substantial agreement. Some children develop at a constant rate while others either fluctuate inconsistently or increase or decrease their rate of mental growth. They show, also, that most children eventually reach a more or less constant rate of growth. This means, of course, that their I.Q. becomes relatively constant. Note, for example, the leveling off of growth rates in Figure 4.12. Dr. Nancy Bayley, director of the Berkeley study, finds "a strong underlying consistency or constancy. Some children forge ahead and maintain relatively advanced positions after five or six years of age. Others grow slowly and lag behind. There is some shifting of position, but the changes are gradual over rather long intervals of time. Within such intervals we can expect to obtain fairly constant standard scores (I.Q.'s)." <sup>37</sup> With respect to observed changes, she says, "Slight irregularities may reflect temporary conditions of motivation, health, or emotional factors. The more constant shifts require other explanations. Though they may result from prolonged emotional or environmental influences, they may also express inherent tendencies to develop at given rates. I suspect that each child is a law unto himself: in some instances certain factors are more important, while in others, different factors play the determining role." <sup>38</sup> With respect to the suggestion that each child is a law unto himself, it is interesting to note that the Fels investigators also stress the "highly idiosyncratic nature"† of I.Q. changes. These they attribute to "complex environmental causes." <sup>39</sup>

It is quite evident, then, that we should not take a specific I.Q. too literally, especially when it is based upon a single test and, even

† They mean by this that the changes observed are peculiar to the given individual under study and not characteristic of most individuals.

more so, when this test is given in early childhood.

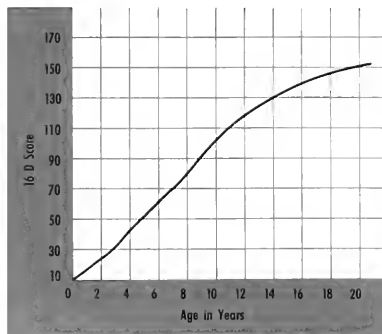
### LIMITS OF MENTAL GROWTH

Mental growth continues until, and even beyond, the time of physical maturity. But when does it reach its upper limit? When does the individual reach the point where he is as versatile as he ever will be in acquiring further skills and information? Does he ever reach a stage where he cannot learn new things as well as he once could? In other words, does versatility undergo a decline? If it does, at what age level does this occur? It is with these and related questions that we now concern ourselves.

The upper limit of mental growth varies with individuals and is related to their general level of intelligence. Generally speaking, those with low intelligence reach their upper limit quite early and those with high intelligence reach theirs at a relatively advanced age.

The general trend of mental growth, as indicated in the Berkeley study, is represented by the curve in Figure 4.13. This curve is

**4.13 Growth of Intelligence from Birth to 21 Years.** This curve is based upon the Berkeley Growth Study. The scores indicated are not raw scores nor are they based upon a single test. They are derived from several tests in terms of standard deviation units, with age 16 as the basis of comparison. Dr. Bayley regards this curve as "not too far from probable trends of growth in intelligence." (From Boyley, N., "On the Growth of Intelligence," *American Psychologist*, 1955, 10, p. 811.)



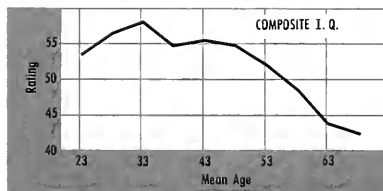
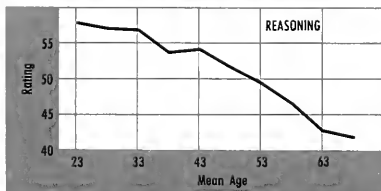
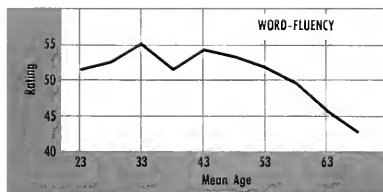
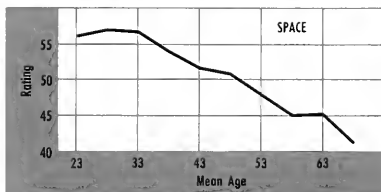
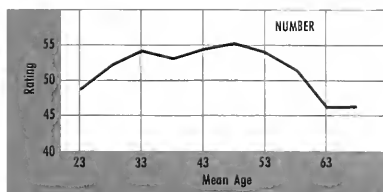
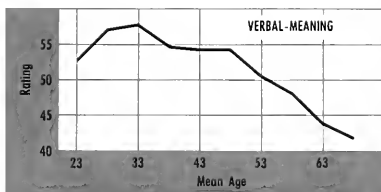
based upon group averages, hence is much smoother than any individual growth curve could be. Individuals, as we have already pointed out, may show a great deal of fluctuation. Note that the slope of the curve is fairly constant between about the third year and the early teens. This means that, on the average, mental growth increases by steady yearly increments as chronological age increases. In the teens, however, the average yearly increments of mental growth become relatively small. By 21, the last age represented, these increments become so small that the curve tends to flatten out. The fact that it does not quite do so, shows that mental growth is continuing, although at a very slow pace. A more recent report for the same group showed further increments up to the 25th year. A point of particular interest about this curve is that it is based upon a group of individuals with higher than average intelligence. Their mean 17-year Stanford-Binet I.Q. was 129. A mental growth curve for a group of below average intelligence would have flattened out sooner.

Cross-sectional investigations have sampled intelligence at age levels far beyond those yet reached by the above study. One of the most extensive of these, which covered the span from 20 to 70 years, yielded the results represented in Figure 4.14. Note that average performance in all categories declined markedly at the upper age levels. In general, this investigation verifies the results of several earlier studies using various intelligence tests.<sup>40</sup>

The decline in test performance at the upper age levels is more evident for some functions than for others. Note, for example, that number ability continues to improve until middle life, a time when other functions have greatly declined. Other studies show that vocabulary remains at a high level throughout the life span while new learning and reasoning both undergo a rapid decline.<sup>41</sup> Observe in the reasoning curve of our illustration that this ability begins to decline even in the twenties.

What we have said about the changes in test performance as old age approaches applies, of course, to groups. It sometimes happens that older persons demonstrate a high degree of test ability. Such persons are rare. What the experiment shows is *not* that the





**4.14 Age Changes in the Primary Mental Abilities.** The mental abilities here represented are those so designated by Thurstone and described earlier in this chapter. (From Schaie, K. W., "Rigidity-Flexibility and Intelligence: A Cross-sectional Study of the Adult Life Span from 20-70," *Psychological Monographs*, 1958, 72, No. 9, p. 18.)

older person knows less as he reaches the higher age levels, but that the readiness with which he acquires further knowledge decreases. When the older adult competes with younger ones and, as is often the case, reaches a similar level of achievement, he usually does so by putting forth a disproportionate amount of effort. It takes him longer to acquire further knowledge, and he tends to be more handicapped than the younger person in retaining and applying it.

#### THE INFLUENCE OF UNUSUAL ENVIRONMENTS

Environmental conditions influence the growth of intelligence in many ways, as previous discussions have indicated, including

those dealing with identical twins reared apart. Here we examine some outcomes of research on adverse and superior environmental conditions.

#### Adverse environmental conditions

Information on the effects of adverse environmental conditions comes from various sources and, as we will see, is subject to different interpretations depending upon one's disposition to favor an hereditary or environmental explanation. Interpretations differ because the individuals involved differed both in heredity and in environment.

Take, for example, the average I.Q. of children isolated from normal educational opportunities. Among these are children

reared in isolated mountain communities, children of gypsies, and children reared on houseboats along the River Thames in England. The average I.Q. of such children is usually far below the national average. One interpretation is that people who live in such conditions have poor inherent capacity to begin with and that their children accordingly inherit a low capacity. This argument may be countered with the fact that the I.Q. of such isolated children is not only low, but that it declines with age. This suggests that, whatever the hereditary background may be, continued residence in an educationally impoverished environment increases the child's handicap in doing mental tests and that the handicap becomes greater the older he gets. A poor environment does not handicap very much at lower age levels where test items are relatively simple and not especially dependent upon a formal education. At higher age levels, where the tests are more complex and more dependent upon what children usually learn in classrooms, from books, and from intelligent conversation, there is a relatively greater handicap. Thus the older child living in educationally impoverished surroundings falls farther and farther behind the group on which the tests were standardized and with which his performance is compared in determining his I.Q. Thus his I.Q. declines the longer he suffers such an educational handicap. It is interesting to observe, in this connection, that improved schooling in an isolated mountain region raised the average I.Q. 10 points over a period of 10 years.<sup>42</sup>

In line with what we have just said about relatively isolated children, it is interesting to observe that the average I.Q. of rural children is usually below the average I.Q. of city children, the difference averaging between 5 and 10 points.<sup>43</sup> This is sometimes interpreted to mean that people who live in rural communities are somewhat lower in inherent ability than those who live in cities, the same argument as used in the case of children living in isolated communities. On the other hand, it can be shown that, in general, the educational opportunities of rural children are usually somewhat inferior to those of city children. This could well account for the small difference between rural and urban I.Q.'s. In any event, one should recognize that these studies are concerned with averages. Some of our

brightest college students come from rural schools and some of our dullest from the most advanced city schools.

#### **Superior environmental conditions**

That superior environmental conditions favorably influence the I.Q. is evident from identical twin studies. It is also suggested by other studies in which heredity was not controlled. The latter are, of course, subject to hereditary as well as environmental interpretations.

Our first illustration is based upon research which shows that a child's I.Q. tends to be higher the higher the socio-economic status of its parents. The average I.Q. of children whose fathers are unskilled laborers is 95 as contrasted with an average I.Q. of 125 for children whose fathers are in the professions.<sup>44</sup> What is the explanation? Is it that people who enter the professions are inherently more capable and thus endow their children with a better inherent capacity than is received by the children of unskilled laborers? This is a possible explanation and it doubtless, in the long run, does account for at least some of the difference in I.Q. But it is by no means the whole explanation, for people with superior socio-economic status usually also have a superior education and more money than those lower in the scale. By and large, therefore, such parents provide their children with a more intellectually stimulating environment than is common at the level of unskilled labor. Compare, for example, the home environments pictured in Figure 4.15. Homes at higher socio-economic levels are likely to have more books, periodicals, newspapers, music, and intelligent conversation than those at lower levels. Moreover, many children at higher socio-economic levels go to better schools than those at lower levels.

It is well to note, however, that there is much hidden capacity among the lower socio-economic groups. This is proved by the fact that many children rise far above the level of their parents. Such capacity can of course best come to light in a society where educational and socio-economic opportunities depend upon capability rather than wealth or social prestige.

Other information on how environmental conditions may influence the I.Q. comes from



**4.15** A Comparison of Two Home Environments. Consider the different intellectual stimulation provided by each of these homes. (Courtesy John Hancock Mutual Life Insurance Co.; St. Louis Post-Dispatch, from Block Star.)

studies of foster children.<sup>45</sup> These are children who, because their mothers are unmarried or because their parents have died or cannot keep them, are placed with foster parents. There are many related problems, but we shall deal with only one of them. This has to do with the effect, on the child's

I.Q., of the foster home in which he is reared. One study demonstrated that children in foster homes rated as poor, average, and good had average I.Q.'s, respectively, of 91, 103, and 111.<sup>46</sup> But were these I.Q. differences produced by the environmental differences? There may be such a relation, but

this is not the sole explanation. Agencies usually try to place the child in a home which corresponds to, or which is better than, the home he might have had with his true mother. Thus there is possibly an hereditary bias at the outset. That is to say, children placed in better homes may have better hereditary backgrounds to begin with. In fact it has been shown in several studies where the intelligence of the true parents was known that the foster child's I.Q. is more closely related to the I.Q. of the true parents than to the I.Q. of the foster parents.<sup>47</sup> It is therefore evident that both hereditary and environmental factors must be considered in accounting for the results of foster home studies.

Except in the cases of identical twins reared in different environments, there is always the possibility that inherent differences rather than, or in combination with, different environmental conditions, are responsible for observed I.Q. differences. The fact that identical twins subjected to markedly different educational opportunities differ in I.Q. (pp. 72-73) demonstrates that inferior and superior environments may, in themselves, influence the level of intelligence.

### ARE THERE RACIAL DIFFERENCES IN INTELLIGENCE?

Many investigations involving comparisons of Negro-white and Indian-white test performance have revealed differences in favor of whites. Do such differences reflect inborn differences in ability between the races? That is a question to which we can give no definite answer, and for reasons which will soon be apparent.

#### Negro-white comparisons

The average I.Q. of northern Negroes\* is about 90; of southern Negroes, about 80.<sup>48</sup>

\* A seemingly inescapable difficulty in all these comparisons is the definition of "Negro." From a genetic standpoint, a Negro is a person all of whose chromosomes are from Negro ancestors, yet many of the "Negroes" of these comparisons may also have chromosomes from white ancestors.

The median Negro I.Q. in twenty-seven studies was 86.<sup>49</sup> The average white I.Q., as the reader knows, is approximately 100. Somewhat comparable differences are found for the Stanford-Binet Scale and other tests. On the AGCT, for example, the average score (not I.Q.) for Negroes is about 69 as compared with 95 for whites.<sup>50</sup>

A recent large-scale sampling of intelligence in terms of a standardized vocabulary also yielded a lower average score for Negroes than for whites, the respective scores being approximately 8 and 11.<sup>51</sup>

Comparisons are less favorable to Negroes when tests are largely verbal. At the pre-school age, where measurement is primarily with nonverbal tests, the average Negro score may equal the average score for whites. Here is an example based upon the Goodenough Draw-a-Man Test. The child is asked to draw a man and he can score as many as 51 points, depending on the number of details included. Since there are age norms, I.Q.'s may be derived. The average white draw-a-man I.Q. is 100. In an investigation in which this test was given to Negro school children, the I.Q. of southern Negroes averaged 79; that of California Negroes 86.<sup>52</sup> But a comparison of Negro and white *preschool children* in New York City yielded no difference in Negro and white I.Q.'s.<sup>53</sup> A study of linguistic development in the same children favored the whites, something about which we will have more to say presently.

Although most studies of Negro-white intelligence favor whites, a few additional facts are worthy of attention. We mentioned earlier (p. 97) the Negro girl with a Stanford-Binet I.Q. of 200. A survey on upper limits of Negro intelligence has revealed other potential geniuses — 18 cases with I.Q.'s above 160, four of them over 180 and one over 200. This indicates that some Negro children are as bright as any white children. As one investigator has said, "Such high I.Q.'s could not be obtained if native potential, environmental stimulus potential, or motivation were at a low level."<sup>54</sup>

Consider, now, the fact that there are regional differences in I.Q. We mentioned in an earlier discussion that white I.Q.'s tend to be lower in rural than in urban communities, where educational opportunities are generally

better. Part of the difference in I.Q. between southern and northern Negroes may be due to the fact that most of the latter live in cities. However, there are other possible reasons and these are worth considering for the light they throw on the general problem of trying to discover native differences in intelligence. One suggestion is that the Negroes who migrate are, on the whole, the brighter ones. If such a selective factor were present it could very well account for the better test performance of northern Negroes. There is evidence that selective migration has not occurred. However, there is another possible explanation. This is the better economic position and educational opportunity available to northern Negroes. In support of this environmental interpretation is the fact that the Negro I.Q. increases with the duration of northern residence. In one investigation the same children were studied from the time they left the South until they had lived for several years in Philadelphia. Their average I.Q. continued to rise throughout the period of observation.<sup>55</sup> This suggests that, whether or not migrants to the North have higher native ability than those who stay in the South, the educational and other advantages to be gained by Negroes from residence in a northern city are definitely influential in raising the I.Q.

Why does residence in the North increase the level of the Negro I.Q.? One should keep in mind that the Stanford-Binet, the Wechsler Scales, and other tests involved in Negro-white comparisons were standardized mainly on white children given average or above-average educational opportunities. They are therefore biased in favor of white children with such opportunities. But the longer a Negro child resides in the North and has improved educational opportunities, the closer his background corresponds to that of the white children on whom the tests were standardized.

The relative disadvantage of Negroes on tests of verbal skill is worthy of closer attention. We pointed out, in discussing the Draw-a-Man results, that Negro and white preschool children did equally well on this test, but that the white children were more advanced in linguistic development. This comparison was based on the length of sen-

tences used by the Negro and white children. Why should Negro preschool children be behind white children of the same age in this respect? Is there a difference in intelligence that is reflected in length of sentences and not in the performance test? These questions cannot be answered with any degree of certainty, but presumptive evidence favors an environmental explanation. The investigators call attention to the fact that Negro families tend to be large, that one usually finds both parents working, and that, as a result of this situation, relatively little time is spent in playing and conversing with the children in such a fashion as to further their linguistic development. Moreover, the Negro parent may himself provide an inferior linguistic model for the child, owing to his own educational deficiencies. Since language plays such a basic role in most of our thought processes, the linguistic retardation of the Negro child could in turn interfere with his overall intellectual development.<sup>56</sup>

In comparing Negro and white performances on intelligence tests we have referred to only a few of the many studies in this area. These are representative, however, and they show the difficulties involved in attempting to reveal the presence or absence of native differences. The following quotation from a recent comprehensive study in this area accents the points already made and adds others.

None of these studies tell us anything about racial differences in native potential. . . . intelligence tests do not in any sense tap native, inherent capacities. In spite of a good deal of research and a rather large body of literature, we know no more today than we did forty years ago. In order to determine whether or not such differences exist, it would be necessary to equate Negro and white groups on all aspects of environmental stimulus potential that might be related to performance on the measuring instrument. In addition, and this is perhaps the crucial factor, motivation to develop learning sets would have to be controlled. The children, white and Negro would have to attend the same schools for the same number of days a year and come from the same or practically identical homes. The teachers and parents not

only would have to assure an equally rich environment for the white and Negro children but also would have to instill the same degree of motivation to make use of this environmental stimulus potential. None of the studies reviewed achieved anything like this kind of control. The factor that is most difficult to deal with is probably that of motivation. Negroes do not have the same expectations of achievement as whites have, not even at the same socio-economic level. They expect to be restricted to certain occupations and to be deprived of many cultural advantages that are open to whites. It seems highly probable that Negroes, therefore, are not even motivated to make full use of such environmental opportunities as are offered. Learning sets may not be developed because they are presumed to have no real value for the individual. Obviously, setting up an experiment to control for motivational differences that are a function of caste values would be a prodigious undertaking.<sup>57</sup>

#### Indian-white comparisons

In various studies comparing whites and American Indians, the average Indian I.Q. has been around 80 as compared with 100 for whites.<sup>58</sup> This difference is not at all surprising in view of the socio-economic and cultural differences which exist between typical reservation Indians and whites. Indeed, everything in the above quotation about the inadequacy of our tests to measure potential ability in Negroes as compared with whites applies equally well to Indians.

There has been much less research on Indian than on Negro test performance. Nevertheless we know that here, as in the case of Negroes, improvements in socio-economic and educational status raise the I.Q. For example, the average I.Q. of Indian children placed in good white foster homes was shown in one study to be 102.<sup>59</sup> Moreover, the oil-rich Osage Indians, with a superior socio-economic and educational status, have an average I.Q. which equals that of whites.<sup>60</sup> However, such results are not clear-cut. There may have been placement of brighter Indian children in white foster homes. It may be argued, moreover, that the Osage Indians with high socio-economic status failed to do

as well on the tests as white people of comparable socio-economic status, whose I.Q.'s, as we have seen, are generally above average.

Part of the Indian-white difference in I.Q. may result from the fact that Indians, with their different cultural background, place less value on education and other aspects of our culture. Motivational differences are also revealed in test administration. Indians are prone to "take their time" while whites hurry to achieve as much as possible within a time limit.

The use of intelligence tests in racial comparisons has not been completely useless, despite the inadequacies of the tests and our consequent failure to reveal the presence or absence of inborn differences. These studies have revealed the wide range of individual differences in all of the groups tested. They have shown, in the case of Negro children, that there is much more ability than was hitherto expected and that, instead of depreciating the mentality of a race, as such, we should respect and utilize ability wherever we find it. Finally, these racial comparisons supplement other data which show that performance on intelligence tests is correlated with various aspects of the individual's social environment.

With the background provided by our discussions of environmental conditions and racial differences, we are now ready to look again at the respective roles of heredity and environment in the development of individual intelligence.

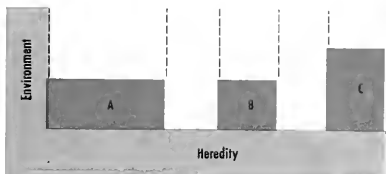
#### THE RELATIVE INFLUENCE OF HEREDITY AND ENVIRONMENT

The individual's intelligence is a function of both heredity and environment. He inherits his organism, with sense organs, brain, and other structures that are important in acquiring intelligence. To the degree that these are defective his intelligence will also be defective, no matter how potentially stimulating his environment may be. But even a normal or superior organism does not guarantee any given level of intelligence. This depends upon the sort of environmental stimulation the individual has had and upon how he has used his opportunities. Thus, for a particular individual, both heredity and en-

vironment are important and it would be difficult, if not impossible, to say how much each has contributed to his intelligence. All that we know directly is the level of his test performance and, since this obviously utilizes what he has learned (what has come from his environment) there is no way to disentangle the environmental and the hereditary contributions. In this connection, Figure 4.16 is of interest. It represents test performance (or intelligence) as a function of heredity and environment.

Differences between individuals may result from heredity, or environment, or both. Take identical twins, for instance. The intelligence of either is due to heredity *and* environment. But one twin may, as we have seen, differ from the other in intelligence, especially when there are large environmental differences. Since they have the same heredity, this difference must be purely environmental. If we could hold the environment constant, as in rats, and produce variations in intelligence by selective breeding, these differences would be purely hereditary. In most instances where we study individual differences, both heredity and environment differ and one cannot disentangle their separate influences. We were made well aware of this fact in discussing differences related to cultural isolation, socioeconomic status, foster homes, and different races. In each of these instances, although a strong influence of environmental opportunities was indicated, the results were confounded by the fact that heredity was not controlled and, in fact, could not be controlled.

Perhaps a few words should be said, in this connection, about I.Q. differences among children who have had "equal opportunities to learn." Under these circumstances it is sometimes assumed that the difference in I.Q., if significantly large, reflects a difference in inherent capacity. But "equal opportunities" are impossible to specify. Even two children in the same school, and perhaps from the same home, may differ in opportunity. They may have had a different health history. Their motivation may differ. That is, one may like school and the other not; one may take school seriously and the other regard it with disdain. The teacher may treat one child kindly and the other harshly. The parents may help and encourage one child more than



**4.16 Heredity and Environment.** Both A and B are represented as having the same environmental opportunities but as differing in heredity. B and C, on the other hand, are shown as having the same heredity but differing in environmental opportunities. (After Woodworth and Morquis.)

the other. How much difference in I.Q. such variations might produce is not known, but that they would produce some effect is almost certain. One cannot, therefore, assume that differences in I.Q., even under seemingly similar circumstances, are due to differences in heredity and to these alone.

Although it is evident that an individual's intelligence is due to both heredity and environment and that differences in intelligence between one individual and another, except in the case of identical twins, are also due to both heredity and environment, one may well ask "Which produces larger differences in intelligence—heredity or environment?" We must answer that, in the most general terms, larger differences are produced by variations in heredity than by variations in environment.

There are no experimental data on human beings to support this view—because we cannot hold environment strictly constant for them—but the results of animal experiments and inferences which may be drawn from the evolution of intelligent behavior unqualifiedly support it. An old saying, which is quite to the point, is that "you can't make silk purses out of sows' ears." What you have to begin with (heredity) always places very large limitations on what you can develop from it by means at your disposal (environment). A rat in a human environment responds only to the grosser aspects of it. A monkey is more responsive than a rat to what a human environment has to offer. A chimpanzee is still more responsive. But the most

favorable human environment could never make a genius out of a chimpanzee any more than out of a monkey or a rat. The differences in intelligence from one of these levels to another are obviously ascribable to the inherited makeup of the organisms involved.

Likewise, a congenital idiot, whose idiocy results from a defective inheritance, a defective prenatal environment, or defective biochemistry (pp. 100-101), will also make relatively little of the opportunities for development offered by a human environment—even the finest that one might provide. His mental growth may be no more influenced by the educational opportunities available than would be that of a chimpanzee. On

the other hand, a child with superior endowment may make the fullest use of the opportunities provided by his environment. He may even get out of a nonstimulating educational environment, whereas the idiot could not if he wanted to.

We say that the initially superior individual *may* make the fullest use of his opportunities because there are many instances, especially at the upper school ages and in college, where those of superior endowment do not do this. Those of low initial ability could not, even if they would, respond to these opportunities in an effective way. Those of high ability, on the other hand, can make good use of them if they are so inclined.

## Summary

Intelligence is a function which may be defined as versatility of adjustment. Its beginnings are found in the learning ability of lower animals. The ability to be modified by what happens and to retain the modifications are important features of intelligence at all levels. Intelligence reaches its ultimate development in the symbolic processes and verbal skills of human adults.

One's intelligence is based upon the kind of brain he is born with, the growth of his brain to maturity, and the way his brain has been modified during his interaction with his environment. Individuals with identical brains at birth would attain different levels of intelligence if subjected to widely different educational environments, that is, if one were reared in an enriched and the other in an impoverished intellectual climate.

The first "scale" of intelligence was devised by Binet and Simon. This had various revisions, culminating in the widely used Stanford-Binet Intelligence Scales. These have themselves undergone three revisions. The latest, an L-M form adapted from the L and M forms of the 1937 revision and newly evaluated, appeared in 1960. Instead of the conventional I.Q., derived by dividing the M.A. by the C.A. and multiplying by 100,

this uses a deviation I.Q. The deviation I.Q. is a standard score. It is based upon the deviation of the child's score from the mean score of his age group. The test is so devised that the mean I.Q. is 100. A lower than average performance results in a lower I.Q. than 100; a higher than average performance, in a higher I.Q. than 100. The meaning of an I.Q., whether conventional or deviation, is always relative to how well a child does in comparison with others—that is to say, with the standardization group on which the test was developed.

Infant tests are of little value in predicting the ultimate level of intelligence. This is because they do not (and cannot at this age level) provide a measure of symbolic functions.

The Wechsler Adult Intelligence Scale and the Wechsler Intelligence Scale for Children include motor and verbal tests. They differ from the Stanford-Binet Test in that items are arranged in order of difficulty without reference to age.

Performance tests are especially useful when the individual suffers from linguistic or other handicaps which make verbal tests inapplicable. Group tests (verbal or performance) can be given and scored by individuals with little training, and they may be admin-



istered to large numbers at a time. While not as reliable as individual tests, these are especially useful when conditions preclude giving the more reliable, but time-consuming, individual tests.

Factor analysis is used to discover how many primary abilities are involved in intelligence-test performance. Spearman believed that there is a general intelligence factor (*g*) involved in all intelligence-test performances, and in many other skills. According to this view, there are also specific factors, or *s*'s. A widely accepted view today is that "general intelligence" comprises several primary functions (or factors). Among those already identified are: number ability, word fluency, verbal meaning, memory, reasoning, spatial relations, and perceptual speed.

The mentally gifted (I.Q.'s above 130) comprise about 2 per cent of the population. Intelligence tests can reveal gifted children and our educational procedures can be adapted to their special needs. With few exceptions, these children become outstanding adults and make important contributions to civilization.

Mental retardation has various origins, environmental and organic. In some instances (isolated mountain children, canal boat children) it may be due, in part at least, to inadequate educational opportunities. Blindness and deafness, unless circumvented by education through touch, can contribute to mental retardation by restricting the environmental input. Many of the feeble-minded (I.Q. to 70 and below) are born with organic defects that are more or less obvious — small brain (microcephalic), excess cerebrospinal fluid (hydrocephalic), inadequate thyroid secretion (cretin), or defective biochemistry related to glandular and other defects (mongolianism, phenylpyruvic feeble-mindedness). Most of the feeble-minded are at the moron level (50–70 I.Q.) and have no obvious abnormalities other than defective intelligence. Many of these can be educated to perform the relatively simple tasks of everyday life.

The mentally gifted and retarded tend to maintain their relative mental status throughout the growth period and at the adult level, but many individuals nearer the middle of the distribution show considerable change in I.Q. Some I.Q.'s increase with age, some de-

cline, some go up and down, and some remain constant. Most individuals finally reach a relatively constant rate of mental growth, their M.A. keeping pace with their C.A. so as to produce a fairly constant I.Q. A mental growth curve plotted from group averages suggests that intelligence (M.A.) increases at a rather constant rate until the teens, then increases more slowly. The upper limit of mental growth (the level at which the individual is as mentally versatile as he will ever be) is dependent upon the individual, and particularly on the general level of his intelligence. The upper limit of mental growth in the feeble-minded is reached relatively early. In the gifted it is reached relatively late. Eventually there is a decline in mental ability, but this comes earlier for some than for others. It comes early for some aspects of intelligence (new learning, reasoning) and late for others (numerical and verbal ability).

The I.Q. is greatly influenced by environmental conditions, both adverse and superior. An adverse environment does not depress it in early as much as in later years, when the child gets increasingly out of step with children who attend good schools and have intellectually stimulating homes. Studies showing that the I.Q. rises with the socio-economic status of parents is subject to different interpretations — those at higher levels may be inherently brighter, they give their children an environment that is intellectually more stimulating. Perhaps both of these factors are involved. Foster home studies show that children placed in homes rated as superior have higher I.Q.'s. But there may be an hereditary bias — children of superior parents being placed in superior homes. Moreover, the child's intelligence correlates more highly with that of his real parents than with that of his foster parents. There is no doubt that superior educational opportunities are effective in raising the I.Q., but there is always the possibility (when heredity and environment are both varied) that some of the improvement depends specifically upon heredity.

Differences in the average I.Q.'s of Negroes and whites, and of American Indians and whites, as commonly tested, are almost universally in favor of the white average. There is much overlapping, however, with many Negroes, for example, having higher

I.Q.'s than average whites — I.Q.'s even at the gifted level. But we have seen that racial groups differ widely in educational and other opportunities. To the degree that these differences are narrowed, differences in I.Q. become smaller. The intelligence tests involved in racial comparisons were standardized on white children in average schools and with wide-open opportunities to advance

to any position in our society. No group that had been denied such educational and social opportunities (Negro, Indian, or white) could reasonably be expected to have as high an average I.Q. as typical whites. Thus there is no basis for concluding that the observed differences in test performance come from inherent differences in the intelligence of the races compared.

(References and notes for this chapter are on page 544 of the Appendix.)

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# Aptitudes



Nature and origin of aptitudes • Aptitude and general intelligence • Aptitude and interests • Tests of special aptitudes • Batteries of factored tests • Developing aptitude tests for particular jobs • Tests of artistic aptitudes • Vocational guidance and selection • Summary

Aptitude is inferred from relative levels of achievement. If individuals given comparable opportunities to acquire a skill differ in the ease of acquiring it, or if they differ in the level of proficiency attained, we say that they differ in their *aptitude* for that particular work.

A student who takes to college work "like a duck to water," making good grades with only reasonable effort, has a high degree of scholastic aptitude. On the other hand, a student who fails to "make the grade" even though he works hard and gets good help from his teachers has relatively little scholastic aptitude. And so it is in many spheres of everyday life. One child profits from musical training while another, given the same opportunities, makes little or no progress. One girl goes to business school in order to become a stenographer. She progresses rapidly with her typing and shorthand and graduates to a job which she carries out efficiently. Another progresses very slowly and, if she graduates, is perhaps an inefficient stenographer. One college student who enters training designed to equip him for life insurance underwriting readily learns the requisite techniques and is soon selling respectable amounts of life insurance while another fails the course, or passes it and has difficulty in meeting and talking with people, so sells little insurance. In each instance we see a marked contrast between persons with a high degree of aptitude and those with a low degree.

As one might expect from our discussion of individual differences, those with high

aptitude for a particular type of activity and those with low aptitude are relatively few in number. Most people have an intermediate degree of aptitude and, in a large unselected group, the distribution is likely to approximate a normal curve.

Aptitude is more or less specific. An individual may have a high degree of aptitude for one line of work and not for certain others. He may do well in scholarship, accounting, or selling life insurance but have very little aptitude for mechanical work. We might make a mechanic out of him, but it would require unusual time and effort and, at best, he might be a poor mechanic as compared with others we could have chosen.

There are, of course, people who have a wide range of aptitudes. Some good scholars, for example, are also versatile in other directions. They may at the same time be skilled mechanics, athletes, musicians, or carpenters. By contrast, there are people who have a very narrow range of aptitudes. These can do only a few things well.

Before the coming of scientific psychology, aptitudes were assessed in a hit-or-miss fashion. Advice to individuals about the vocation they should enter was based upon intuition, upon hunches. Employers worked on a similar basis. They took in those they thought might succeed and dropped them if they did not. The scientific method of dealing with such problems is to study the requirements of the job, design tests which measure individual differences in the abilities required, try out such tests to see how accurately they predict success in the particular occupation, then use those with predictive value as a basis for vocational advice and selection. Following this general procedure, psychologists have devised and standardized aptitude tests for a wide variety of occupations. Quite often the individual is given a battery of separate tests, each measuring some ability relevant to a particular occupation. His performance is then rated in terms of how closely it approximates the needed aptitude pattern.

As suggested above, there are two main general reasons for attempting to measure aptitudes. One of these is to advise youth concerning the fields of activity in which they are most likely or least likely to be successful. The other is to select those best fitted for particular jobs, the aim being to select, before training, those who will most likely succeed in a given occupation. When this aim is achieved, much time and effort ordinarily expended with the potentially unsuccessful is saved. The first-mentioned application of aptitude testing is thus in the interest of *vocational guidance*; the second is in the interest of *vocational selection*. Although these aims are different, the tests used may be identical. The difference lies in the reason for giving the tests and in the uses to which they are put.

Before turning to a discussion of typical aptitude tests and how they are standardized and used it is worth while to consider in more detail the nature and origin of aptitudes.

## NATURE AND ORIGIN OF APTITUDES

Certain aspects of many aptitudes are inborn. Some individuals have longer and more dexterous hands than others. When it comes to such skills as typing, making watches, playing the piano, and perhaps carrying out certain surgical procedures, these will have an advantage over those with short stubby fingers and awkward hands—the so-called “ham-handed.” Some people, because of the way they are constituted, can respond more quickly than others. In certain kinds of work, these have an advantage over those who are

constitutionally slow to react. Some of us are perhaps naturally stronger than others, hence better fitted for jobs requiring heavy work. But inborn characteristics do not tell the whole story. There is no doubt that earlier acquisitions, including interest in a certain line of work, are also of great importance. You may have dexterous fingers, yet no interest at all in becoming a watchmaker. If you do enter such an occupation, a person with less innate ability but greater interest than yours, may well outdistance you.

Thus, in saying that one person has greater

aptitude than another for some job, we neither imply that the aptitude is inborn nor that it is acquired. It is in all probability dependent upon both our heredity and what we have learned. In a practical situation we have before us an individual whose aptitudes, whatever their origin may have been, are already established. As a well-known investigator of aptitudes said:<sup>1</sup>

We want the facts about a person's aptitudes as they are at present: characteristics now indicative of his future potentialities. Whether he was born that way, or acquired certain enduring dispositions in his early infancy, or matured under circumstances which have radically altered his original capacities is, to be sure, a question not only of great theoretical interest, but of profound importance to society at large; for the answer has a bearing on public policy in regard to universal education, the functions of the school, and eugenic legislation. But it is of little practical moment to the individual himself at a time when he has already reached the stage of educational and occupational planning. His potentialities at that period of his development are quite certainly the products of interaction between conditions both innate and environmental. His capacity for gaining manual skills, his intelligence, his emotional makeup, his moral character, indeed all aspects of his personality, are in varying degrees subject to limitations that have been imposed by opportunities for growth and exercise, as well as by his original nature. No matter what his constitution may at first have been, it has unfolded, taken shape, been encouraged here and thwarted there, during the impact of favorable or unfavorable stimulation from the environments in which he has developed. And so, when appraising his aptitude, whether for leadership, for selling, for research, for artistic design, we must take him as he is — not as he might have been.

From what we have already said, it is perhaps clear that aptitude and present ability do not mean the same thing. You may have no present ability to fly a plane, but you may have a high degree of aptitude for flying — which means that your chances of being a successful flyer are good, provided you receive the proper training. The chief value of

aptitude testing is, in fact, that it enables us to pick out from those who do not yet have the ability to perform certain skills those who, with a reasonable amount of training, will be most likely to acquire the skills in question and acquire them to a desirable level of proficiency.

## APTITUDE AND GENERAL INTELLIGENCE

Performance on intelligence tests is sometimes indicative of aptitude for certain lines of work. In fact the use of intelligence tests in both world wars was for the purpose of selecting, from the millions drafted, those who would be most likely to profit from specialized forms of training. Selectees in World War II were given an opportunity to train as pilots only if they made higher than a certain score on specially devised intelligence, aptitude, and information tests.

High scores on good intelligence tests indicate ability to profit from academic training or what is often called *scholastic aptitude*. When such tests are used to pre-select college students, for instance, the per cent of students dropping out in their freshman year or later is sharply reduced from that expected in a less well-selected class. With personality and interest tests added, there would be an even greater reduction in the per cent of students leaving college. There are of course always some who drop out for other reasons than poor scholastic aptitude.

Some widely used tests of scholastic aptitude involve two types of items, one type measuring linguistic ability, the other, quantitative ability. Items in the *linguistic* part of the tests are very much like those in the verbal tests of intelligence with which we are already acquainted, and especially Thurstone's measures of word fluency (factor W) and verbal meaning (factor V). Items dealing with *quantitative ability* are like those used by Thurstone to measure number ability (factor N) and spatial relations (factor S).

Although scholastic aptitude tests often differentiate verbal and number abilities, much as Thurstone's tests do, their items tend to be more complicated than his and more dependent upon specialized experience with verbal and numerical concepts. For example, the general aptitude section of a test designed to

select students for graduate schools \* involves linguistic and quantitative items like the following:<sup>2</sup>

Andrew Jackson believed that wars were inevitable, and to him the length and irregularity of our coast presented a \_\_\_\_\_ that called for a more than merely passive navy.

- (A) defense (B) barrier (C) provocation  
(D) vulnerability (E) dispute

A man traveling 100 miles at  $r$  miles per hour arrived at his destination 2 hours late. How many miles an hour should he have traveled to arrive on time?

- (A)  $\frac{50-r}{50r}$  (B)  $\frac{50r}{50+r}$  (C)  $\frac{100-2r}{r}$   
(D)  $\frac{50r}{50-r}$  (E)  $\frac{50r+1}{50}$

The correct alternatives are given on page 490.

These are relatively simple items, designed merely to indicate the nature of the test itself, but they illustrate the sort of verbal and quantitative ability measured by this and similar tests.

Verbal ability is especially important in courses which require much reading and the understanding of concepts expressed in words. Quantitative ability, on the other hand, is required to a high degree in mathematics and in science courses like physics and chemistry.

Tests of medical aptitude are used by many universities to aid in the selection of students planning to enter medicine. These are also very much like intelligence tests. The chief difference between such tests and tests of general intelligence, however, is that the former

place considerable emphasis on achievement in a specialized subject matter. Thus the *Medical College Admissions Test* measures verbal and quantitative ability along the lines already described, but it also contains specialized material dealing with the fundamental principles of science and with current social issues. Although the items dealing with scientific material involve conceptual thinking and other processes of a general nature such as intelligence tests measure, they also utilize specific material available only to those who have studied biology, physics, and chemistry. Likewise, the items which test one's understanding of modern society involve verbal reasoning and other aspects of general intelligence but they have reference to social issues which are evident only to the socially alert individual.

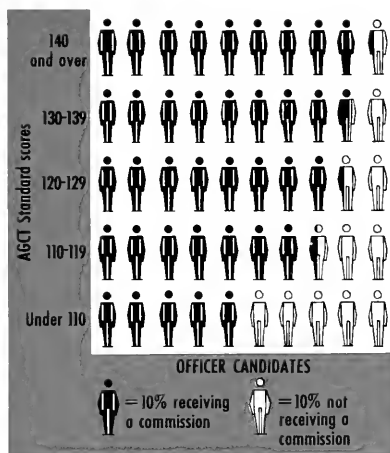
There are other aptitude tests designed to select students for special academic and professional fields, including teaching and law. All of them are in many respects like intelligence tests and there is usually a substantial correlation between scores on these tests and scores on tests of general intelligence.<sup>3</sup>

General intelligence is also related, but in less obvious ways, to many other kinds of endeavor. There are certain jobs which cannot be performed successfully by those whose intelligence is below a given level.

A suggestion of the limits of intelligence in individuals employed in various kinds of activity ranging from unskilled to professional work is given by the data in Table 5.1. This table is based on AGCT scores (p. 92). The individuals tested were those selected for the armed services, hence some professions, including medicine and dentistry, are not included. Only a few representative occupations are listed here. Note, moreover, that the scores given are neither raw scores nor I.Q.'s, but standard scores (see p. 62). Bookkeepers, for example, had a mean standard score of 120. However, some bookkeepers had a score as low as 70 and some as high as 157. Although the standard scores decrease as one goes from lawyer to miner, there is a wide range of scores at every level. There is thus much overlapping from one occupation to another. Some miners, for example, make higher scores than some lawyers and engineers.<sup>4</sup>

One occupational use of AGCT scores is sug-

\* This is the *Graduate Record Examinations Aptitude Test*. It includes a general aptitude test which, as described above, differentiates verbal and quantitative abilities, and also a comprehensive test in the specialized field in which the student hopes to do graduate work. The specialized test is of course more an achievement than an aptitude test, although it is evident that achievement in college courses can be used to predict performance in the same areas at the graduate school level.



**5.1 Predicting Success of Officer Candidates from Their Grades on the AGCT Test.** This chart shows the per cent passing the officer training course and receiving a commission. (After Boring.)

Table 5.1. Mean AGCT Scores and Range of Scores for Various Civilian Occupations\*

Occupation	Mean standard score	Range of scores
Lawyer	127.6	96-157
Engineer	126.6	100-151
Teacher	122.8	76-155
Bookkeeper	120.0	70-157
Radio repairman	115.3	56-151
Salesman	115.1	60-153
Machinist	110.1	38-153
Mechanic	106.3	60-155
Plumber	102.7	56-139
General painter	98.3	38-147
Truck driver	96.2	16-149
Farmer	92.7	24-147
Miner	90.6	42-139

\* Selected from a much more extensive table in Harrell, T.W., and M.S. Harrell. "Army General Classification Test Scores for Civilian Occupations." *Educational Psychol. Measurement*, 1945, 5, 231-232.

gested by the following facts. More than 90 per cent of officer candidates who had an AGCT standard score of 140 and over actually became officers. As Figure 5.1 shows, the percentage of successful candidates decreased as the test scores decreased. Of those with scores under 110, only 50 per cent passed the officer training course.

Generally speaking there is a minimum intelligence level required for success in certain occupations, including those in the armed services. If the individual's intelligence were below the minimum for a given occupation, he would be advised against entering that occupation. If it were above the minimum, we would then measure other aptitudes relevant to that occupation.

In selection of individuals for certain jobs, a minimum intelligence score is sometimes set. In the case of officer candidates a standard AGCT score of 110 was finally required. All who failed to reach it were denied officer training. This score was actually higher than the minimum needed by officers, but it is customary in many occupations to set the critical score at a higher level than the minimum.

There is the danger, of course, that some are on this basis prevented from entering an occupation who might succeed despite their low intelligence score. But what those concerned with selection try to do is to set a score which, as indicated by preliminary experimentation, will give the highest percentage of potentially successful individuals, without eliminating too many who might succeed.

Intelligence is seldom the sole basis for guidance and selection. Interests are very important, as also are specific aptitudes. We will now consider the relation between aptitude and interests, then take up the nature and measurement of specific aptitudes.

## APTITUDE AND INTERESTS

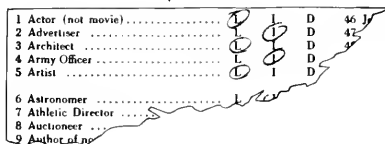
One of the best single indicators of possible success in certain occupations is the way in which the interests of candidates compare with those of people who are successful in these occupations. It is, of course, possible for a person to be interested in something, like being a salesman, yet have little or no aptitude for it. Nevertheless, in choosing a group of salesmen who would, as a group, be successful, the interest inventories are very useful.

One well-known and widely used vocational interest inventory is Strong's Vocational Interest Blank. In filling this out, a person indicates his "like," "dislike," or "indifference" (see Figure 5.2) for a wide range of occupations, amusements, school subjects, sports, and undertakings. There are 400 items in all. The responses are scored with keys designated "Artist," "Psychologist," "Architect," and so on. There are separate blanks and scoring keys for men and women. The key for "Artist" is based upon the predominant reactions of successful artists to items in the interest blank. Likewise, each of the various scoring keys for both male and female occupations is based on the predominating reactions of individuals in those occupations. A sample report and its analysis is shown in Figure 5.2.

Another widely used interest inventory is the *Kuder Preference Record*, which comes in three forms.<sup>6</sup> One of these, the vocational, is scored for various interest patterns. Scores are reported for outdoor, mechanical, computational, scientific, persuasive, artistic, literary, musical, social service, and clerical interests. Another form of the Preference Record gives an inventory of interests in the personal area — interest in group activities, in familiar rather than new experiences, in working with ideas, in avoiding conflict, and in directing and influencing others. A third form of the Preference Record, recently developed, scores the subject's reactions in terms of particular occupations (farmer, minister, accountant, and so on). In this respect it is similar to the Strong Vocational Interest Blank.

Strong found that those who succeed as real-estate salesmen, for example, have a pattern of likes, dislikes, and indifferences which differs from that of those successful in certain other occupations. A person whose pattern of interests closely coincides with that of successful architects has a leaning, at least, in the direction of being a good architect.<sup>5</sup> The person whose interests are represented in Figure 5.2 rates A for interest in architecture, and only C for interest in psychology. His interests are thus predominantly like those of architects

Sample from test



Type of report received by individual

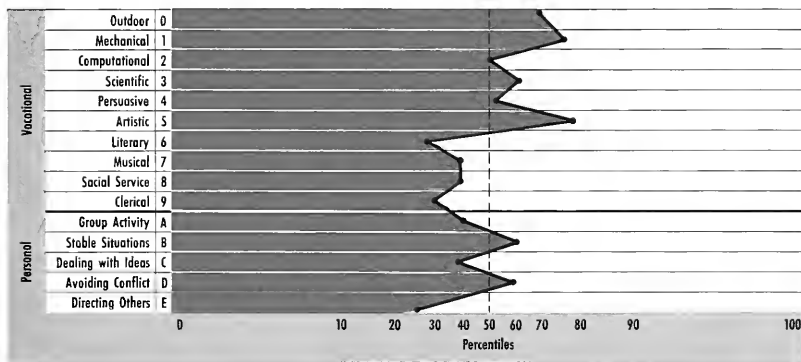


Put your answers to these questions in column O.

- P. Visit an art gallery . . . . .
- Q. Browse in a library . . . . .
- R. Visit a museum . . . . .
- S. Collect autographs . . . . .
- T. Collect coins . . . . .
- U. Collect butterflies . . . . .

	O	
	• P •	
	• Q •	← LEAST
MOST →	• R •	
	• S •	
MOST →	• T •	
	• U •	← LEAST

**5.3 Items from the Kuder Preference Record.** Of the alternatives P, Q, and R, this person likes Q least and R most. He likes S most and U least of the alternatives S, T, and U. The pinprick is an automatic marking device, since the pricks fall into various patterns on a score sheet below. (Courtesy Science Research Associates.)



**5.4 Profile Based on the Kuder Preference Record.** Note that percentile ranks are indicated and that both vocational and personal interests, as described in the text, are represented. (Courtesy Science Research Associates.)

that he likes least of the three, and to the left of the activity that he likes most. As the holes are penetrated, the point punches underlying score sheets containing a different pattern of circles for each interest area. The number of punched circles on the sheet for "outdoor" is then counted, then the number on the sheet

for "mechanical," and so on. The resulting scores are finally translated, from a table, into percentiles. These are plotted to form interest profiles, of which Figure 5.4 is an example.

Observe that the student whose profile is reproduced here is interested predominantly in outdoor activities, work of a mechanical na-

ture, and artistic pursuits. He also prefers familiar (stable) to new situations and situations characterized by friendly relations rather than those involving social conflict. These expressed interests, added to what the counselor learns about the student's intelligence and his aptitudes for specific activities, can provide a valuable basis for vocational counseling. In business and industry, the same information may be used in selecting persons best fitted for particular lines of work.

## TESTS OF SPECIAL APTITUDES

Tests of specific aptitudes fall into two broad categories—*pencil-and-paper* tests of the kind already familiar from our discussions of intelligence tests and *manipulatory* tests in which the individual handles the test materials in certain ways.

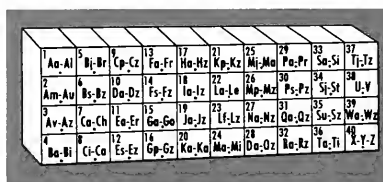
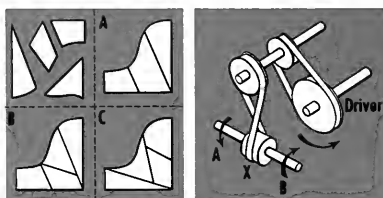
### Pencil-and-paper tests

Two pencil-and-paper items from tests designed to measure aspects of mechanical aptitude are reproduced in Figure 5.5.

The first example is representative of items in the Minnesota Paper Formboard.<sup>7</sup> Here the individual being tested is required to indicate whether the pieces in the upper left-hand corner, when fitted together, produce A, B, or C. There are sixty-four problems like this in the test, but most of them are far more complicated. The ability being tested is doubtless related to the spatial relations factor in Thurstone's test (p. 94).

Our second example is much less like items to be found in intelligence tests, the reason being that it measures the sort of mechanical understanding which is more closely dependent upon actual experience with mechanical principles, either in a physics course or in everyday life. This item is like many in the Bennett, Seashore, and Wesman Mechanical Reasoning Test, a test widely used to select persons fitted for a variety of mechanical occupations, including that of airplane pilot.<sup>8</sup> For every such item, the examinee makes a response requiring mechanical judgment. In this instance he is asked, "If the driver turns in the direction shown, which way will the pulley at X turn?" He indicates his judgment by marking A or B on the answer sheet.

As a third example of pencil-and-paper tests we take an item designed to measure alphabetizing ability, a skill so important in clerical and related occupations.<sup>9</sup> The person being tested indicates in which file one should place letters or other material relating to the named individuals. There are, of course, many such items and the speed and accuracy with which the individual does the series determines his score.



Kuczmarski, H. G. ....  
Davidson, C. H. ....

**5.5 Pencil-and-Paper Tests of Specific Aptitudes.** The Minnesota Paper Form Board has items like A. This item is not from the actual test but simulates those in the test. The examinee, as described in the text, indicates which figure is composed of the pieces in the upper left-hand corner. B is from the Bennett, Seashore, and Wesman Mechanical Reasoning Test. With the driver moving in the direction shown, will X move in the A or B direction? Item C is from the alphabetizing subtest of the General Clerical Test. After each name, of which this sample has only two, the examinee gives the number of the drawer in which the records should be filed. Speed of filing is an important aspect of this test. (The Psychological Corporation.)



## 5.6 The Minnesota Rate of Manipulation Test.

As described in the text, the examinee must pick up, turn over, and replace the small cylindrical blocks, being timed while he does so. (Courtesy Dr. Kenneth Clark.)

### Manipulatory tests

There are also many tests of a manipulatory nature, but only three are illustrated here. Two of them fall within the general area of *manual dexterity*. This is versatile or skillful use of the hands. The third example is representative of tests which measure *eye-hand coordination*.

The test shown in Figure 5.6 is similar to many manual dexterity tests. In this, the subject is required to pick up, turn over, and replace small cylindrical blocks in four rows of 15 holes each. His score is the time required to complete this operation.<sup>10</sup>

The item illustrated in Figure 5.7 is more specifically a test of *finger dexterity*.<sup>11</sup> The examinee is timed while he picks up pins with the tweezers and inserts them into small holes, places small collars over the pins, puts small screws into threaded holes, and screws them down. It is in manipulating these items that finger dexterity is especially involved.

Our third example (Figure 5.8) is a test which, although it involves a certain degree

of hand and foot dexterity, is more concerned with measuring the speed with which certain complex eye-hand coordinations are carried out.<sup>12</sup> This test was developed for the selection of prospective pilots. It uses a simulated cockpit with rudder bar and stick. The individual being tested sits with his hand grasping the stick and his feet on the rudder bar. The panel before him has parallel sets of bulbs. The three groups of 13 pairs each are used in the test. In one row of each pair is a red light which stays fixed when the lights come on. As the stick is moved from the central position to the left, green bulbs light up successively to the left in the lower top row. As it is moved to the right, they light up successively to the right. The candidate's job is to match a green light with the red, so that one appears directly below the other. Likewise, by moving the stick forward or pulling it back, he controls the lighting of green bulbs in the central column, and must get a green light opposite the red one. Similarly, the rudder bar is manipulated with the right or left foot to match red and green lights in the bottom group. As soon as all three red lights are matched with green ones by appropriate manipulation of stick and rudder bar, the red lights shift to new positions. Then the procedure just described is repeated. This continues until 40 settings of three red lights each have been matched.

There are many tests of specific aptitudes, both pencil-and-paper tests and those involving manipulation. However, the examples given are more or less typical. Many such tests,

## 5.7 Small Parts Dexterity Test.

The examinee is timed while he assembles the parts in the appropriate holes. (The Psychological Corporation.)





**5.8** The School of Aviation Medicine Complex Coordinator. The red light goes on in each of three sets (upper, lower, and central). By appropriate manipulations of the stick and rudder bar, the examinee must light the green bulbs opposite the red ones. (Air Force Photo.)

rather than measuring each a different aptitude, are measuring the same aptitude. We now turn our attention to this problem.

#### The search for aptitude factors

It is perhaps obvious that all of the aptitude tests already described have certain underlying similarities. In fact, performances on most of them are positively correlated one with the other.

To some extent, all these tests tap aspects of intelligence. This is partly because a certain degree of intelligence is necessary to understand and follow instructions. Beyond this, some aptitude tests call for a certain degree of verbal skill — for example, the alphabetizing test previously described. We have already learned that verbal skills are important aspects of human intelligence, as, also, are perceptual

and numerical skills. Thus, to the extent that perceptual and numerical skills are called for in aptitude tests, we can expect to find that scores on intelligence tests and scores on aptitude tests are correlated. Likewise, practically all tests, whether of intelligence or special aptitudes, are timed. We allow the individual only a specified time in which to do the test, or we ascertain how long it takes him to do a specified number of items, or to assemble a certain number of bolts and screws, or turn over and replace a specified sequence of blocks, or complete the series of coordinations of the complex coordinator. Since time is an aspect of all such tests, we would expect some of the correlation between them to depend upon speed.

Because test performances tend to be positively correlated, psychologists have sought to discover the essential components of a wide

range of tests. We saw, in an earlier discussion (p. 94) that intelligence, rather than being unitary, involves various subsidiary abilities. These were referred to as *factors* in intelligence. One will recall that seven factors were identified as contributing to so-called "general intelligence," viz., number ability, word fluency, verbal meaning, memory, reasoning, spatial relations, and perceptual speed. In discussing these, we called attention to the value of measuring identifiable abilities as contrasted with measuring a heterogeneous integration, as in the usual intelligence test. We said that there are certain skills (e.g., mechanical) which correlate in a negligible way or not at all with scores on tests of general intelligence, yet which might correlate significantly with a particular primary factor or group of such factors. Thus, if spatial relations and perceptual speed were correlated with mechanical skill, we could use tests of these factors, rather than a general intelligence test, in attempting to predict success in mechanical work. This would naturally save much time and energy, for most of what is in a test of general intelligence would, for our purposes, be wasted.

The success of Thurstone and others in factoring intelligence suggested the value of applying similar techniques in the field of aptitude testing. Before factored tests were available, it was customary for psychologists to assemble a group of tests which appeared appropriate for the task at hand. But there was no way of knowing whether several of these tests were measuring the same thing; or, in fact, whether this combination measured every needed aptitude. Examination of the results of such tests showed that many were indeed wasteful.

The general procedure used to identify aptitude factors is as follows: A variety of aptitude tests is assembled and these are administered to a large group of individuals comparable with those for which the tests were designed; for example, aviation candidates, if the tests are intended for selection of pilots. Performance on each test is then correlated with performance on every other test. The resulting  $r$ 's are then arranged in tables which show at a glance to what degree each test is correlated with other tests. Such a table of intercorrelations will show that there are degrees of correlation. Some tests correlate to

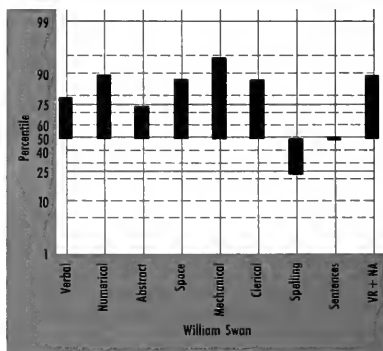
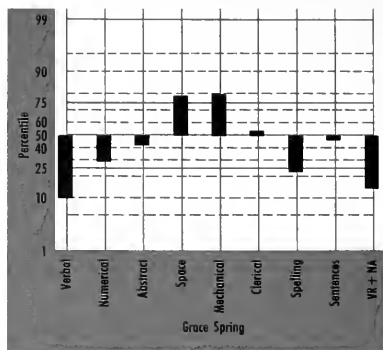
a high degree and others to a lesser degree. Some correlate negligibly or not at all with each other. Tests which yield high intercorrelations are of special interest. Perhaps they are all measuring the same aptitude. Several such tests, let us say, all appear to involve speed of reaction to a high degree. This suggests that they may be measuring a speed factor. Factor analysis (the details of which are too complicated for discussion here) may show that all such tests are indeed measuring speed and little else, or it may show that, although they are measuring speed to some degree, all are measuring one or more other variables. Tests shown by such an analysis to be measuring speed of reaction and little else may then be used as relatively "pure" tests of a speed factor.

The two aptitude batteries now described are representative of several based upon factor analysis.

#### BATTERIES OF FACTORED TESTS

As our first example of a factored test battery we take the *Differential Aptitude Test*, or DAT.<sup>13</sup> Performance on the DAT is used in many high schools to supplement what is known about the student's I.Q., his educational record, and his interests. Its various subtests measure the following factors, some of which are also measured by Thurstone's factored tests of intelligence: *verbal reasoning, numerical ability, abstract reasoning, clerical speed and accuracy, and language usage*. The latter differentiates between *spelling* and understanding of *good sentence structure*. Another score is sometimes derived from the sum of the scores for verbal reasoning and numerical ability ( $VR + NA$ ). This is an indicator of scholastic aptitude.

After a student has taken the DAT, the counselor may construct test profiles like those shown in Figure 5.9 and use these to advise concerning school and vocational goals. Observe that bars show the percentile rank for each factor and that these are anchored on the line representing the 50th percentile. The first profile in our illustration is that of a ninth grader, referred to here as William Swan. William's abilities seemed high, yet he was entered in a four-year terminal agricultural course. When he was called into the office and given the DAT his abilities were found to be



**5.9 Counseling with the DAT.** Test profiles (see samples above which are discussed in the text) are used to advise individuals concerning their academic and vocational aims. Sometimes a score which sums the verbal and numerical scores is also used. See the last column on these profiles. (The Psychological Corporation.)

average or better in everything but spelling. The following analysis of William's situation is from the counselor's report.<sup>14</sup>

On the basis of the *Differential Aptitude Test* scores, substantiated by the teachers' reports that William had become the first-ranking student in the agricultural department, the counselor invited the boy in for a conference. William's plans for the future, the DAT results, and his work in the agriculture

course were discussed in detail. William expressed dissatisfaction with the agricultural program since he felt that he wanted "to learn more."

In a subsequent interview, the requirements for schools offering degree courses in agriculture were explored. After he had acquired this information, William felt that he would like to attend a college which grants degrees. However, he doubted that he would be able to secure the necessary funds.

At the counselor's request William's father came for an interview. College entrance requirements and costs as well as William's potentialities for success in college were discussed. The father showed understanding of these topics and made it clear that he would be able to provide sufficient funds for the boy's education. The counselor also discussed the possibility of scholarship assistance if William continued to earn superior grades.

On the basis of the assembled information and the boy's own determination, as well as that of his family, arrangements were made for William to transfer to the college preparatory course. In his first year in high school William has done honors work, receiving five grades of Excellent and three of Good.

The second profile in our illustration is that of an eleventh-grade pupil referred to as Grace Spring. Her problem was that she was failing in the commercial program and wanted to discuss the possibility of changing to something else. She had a good *Kuder Preference Record* (pp. 120-121), which showed that her choice of program "was in line with her interests as she recognized them." But "neither her program nor her interests matched her abilities very well." One will observe from her DAT profile that Grace was well above average in only two things, *space relations* and *mechanical reasoning*. These relatively high scores compared with her "poor-to-middling scores in the aptitudes pertinent to clerical or secretarial work, warranted some effort aimed at arousing new interests and altering her plans." The counselor's report,<sup>15</sup> already quoted in part, continues:

The result of the counseling sessions was that Grace requested transfer to the dressmaking course in the Vocational School. This request was honored, with good results in both achievement and attitude. She is doing good work in the shop courses and average work in the remainder of her classes. Her attendance has improved, and she now expects to qualify for a regular high school diploma.

A single I.Q. rating for this girl — or even a verbal-and-numerical or verbal-and-nonverbal comparison — would not have been sufficiently diagnostic. The aptitude basis for her

plan to enter the dressmaking course could not have been adequately appraised. A decision based in part on analysis of her *Differential Aptitude Test* profile made good sense to her and to her counselor.

These illustrations give a good idea of how DAT profiles are used in counseling students. But suppose that a person is looking for a position with prospects of success and he approaches the United States Employment Service (USES)? In this event, he will take a battery of tests<sup>16</sup> which are quite different from the DAT. The test battery used by the USES includes an intelligence test and factored items like verbal and perceptual ability, but it also includes tests more directly oriented toward specific occupational skills. There are, for example, tests of manual dexterity, precision of movement, and speed of coordinated reactions. The battery has fifteen subtests designed to measure "10 aptitudes which, in varying degrees and combinations contribute to occupational success." Different *aptitude patterns* are required in different occupations. Here are a few examples:

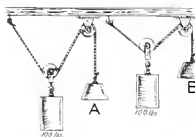
Pattern GV — intelligence and verbal ability. Certain critical scores are set for such occupations as creative writing and journalism.

Pattern GN — intelligence and numerical ability. Critical scores are set for such occupations as accounting.

Pattern GNSF — intelligence, numerical ability, spatial ability, and finger dexterity. Critical scores are set for metal machining and mechanical repairing.

Pattern NSM — numerical ability, spatial ability, and manual dexterity. Critical scores are set for heavy metal structural work, plumbing, and wood construction.

After an individual has taken the test battery, his test profile is compared with the minimum scores required in twenty different occupations. Thus, if his scores equal or exceed those that make up the GNSF pattern, he may be advised to obtain appropriate training and take up some occupation involving mechanical repair work. But test scores are not the sole basis for such decisions. The counselor also takes into consideration the individual's interests, his personality, his pre-



Which weight must be heavier to support the 100 pounds in the position shown?

A B Equal

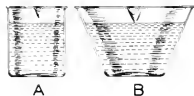
High Group

58% Correct

Low Group

53% Correct

Question 1



In which of these round jars will the liquid press harder on the bottom?

A B Equal

80% Correct

35% Correct

Question 2

**5.10 Item Validity.** Both test items look good. They have "face validity." Moreover, they are about equal in difficulty, being answered correctly by 56 per cent to 58 per cent of those to whom they were administered. But observe that the group rated high in mechanical comprehension did not do much better on Item 1 than the group rated low in mechanical comprehension. Item 2, however, clearly differentiated the high and low groups, hence it was judged a valid item for selecting those with mechanical comprehension. (From *The Test Service Bulletin*, No. 51, copyright 1941, The Psychological Corporation.)

vious work experience, and other relevant factors not covered by the test battery.

These examples show the nature of general aptitude batteries and also how the outcomes of test administration may be used in vocational guidance and in selecting people best fitted for certain occupations. But the reader may well ask: "On what basis are test items selected?" "How does the psychologist know which separate abilities and ability patterns are required in a particular occupation?" "How does one find the minimal intelligence, the minimal finger dexterity, or the minimal reasoning ability, singly or in combination, which a particular occupation requires?" The following discussion is designed to answer such questions.

#### DEVELOPING APTITUDE TESTS FOR PARTICULAR JOBS

Although there are many tests of specific aptitude, factored or otherwise, the particular pattern relevant to a specified occupation must be determined by experimentation. In the Second World War, the Army Air Force psychologists did not have ready-made tests for selection of pilots, bombardiers, and navigators. It was necessary to devise suitable tests.

Psychologists in the Bureau of Aeronautics of the Navy Department also had to develop their own tests. The U.S. Employment Service, confronted with selection problems in still other areas, devised the test batteries already described.

Psychologists in business and industry can sometimes use tests already available, but for most jobs there are no ready-made aptitude batteries. Thus, in selecting people for particular jobs, the psychologist may have to adapt tests already in use, combine these into suitable batteries, or perhaps devise completely new tests. In any event, he must ascertain experimentally whether use of the tests improves selection sufficiently to justify the time and expense involved in administering, scoring, and evaluating them. An item, or combination of items, may look reasonable, yet contribute little or nothing to the selection process. Compare, for example, the two test items in Figure 5.10. On the face of it, we might judge either to be a good test of mechanical comprehension. Nevertheless one differentiates those with good and those with poor mechanical comprehension and the other does not.

How do we know that one item measures mechanical comprehension and that the other



does not? In the example given, the score on the total test of mechanical comprehension was used to select a high and a low group. Each item was then evaluated in terms of how well it alone differentiated these groups. An item which does not differentiate is worthless. It does not "pull its weight in differentiating people in the desired way,"<sup>17</sup> hence it is dropped from the test. Each part of a well-standardized test is subjected to an *item analysis* of the sort described.

But, one may ask, how do you know that the test as a whole is really related to mechanical skill? One cannot know at the outset. A test may be internally consistent — i.e., all items in it may differentiate — yet the test may not measure what it purports to measure. Many tests have been developed to predict success in particular fields and then it has been found that they do not predict. This is the problem of *validity* which was mentioned in earlier discussions of statistics and R-R laws (pp. 47-48) and to which we will turn shortly.

Actually, the development of an aptitude test or battery requires a series of steps of which the determination of validity is the final one. These steps are as follows:

- (1) Analysis of the job for which the tests are to be used;
- (2) tentative selection and arrangement of items which appear to measure the psychological processes disclosed by the job analysis to be important for that job;
- (3) development of a standardized method of administration and scoring;
- (4) administration of the tests to a large and representative group of individuals from the population on which they are finally to be used; and
- (5) analysis of results to discover whether the tests are good predictors of success in the occupation for which they are designed, i.e., whether they are valid.

*Job analysis.* Regardless of whether an aptitude test is devised for vocational guidance or for vocational selection, the first thing that the psychologist usually does before designing it is to make a detailed analysis of the psychological processes required in successful performance of the job in question. Before designing certain tests of flying aptitude, psychologists went aloft with experienced pilots, bombardiers, and navigators. While aloft, they observed the pilot, bombardier, or navigator's performances. Some of them went through the

training process themselves, paying particular attention to the kinds of abilities they were called upon to use. After gathering relevant information on the requirements of the job in this and other ways, they were then ready to design batteries of aptitude tests for pilots, bombardiers, and navigators. Similarly, psychologists have gone into industry and observed skilled performance or learned the performance themselves.

*Tentative selection of test items.* After a job analysis has been completed and some insight into the nature of the processes required has been gained, the psychologist then selects tests from those already available or devises tests to measure these processes. Suppose a certain level of intelligence seems important, then he may try out one or more of the many intelligence tests available. Suppose that calmness under conditions of stress is one of the requirements, then he may try out some of the devices used in the laboratory to record physiological changes in emotion. Suppose that hand-steadiness is involved, then he may try out a test of hand-steadiness. Suppose that ability to react quickly to a stimulus seems important, then he may test speed of reaction with a chronoscope. Suppose that a certain kind of finger dexterity seems to play an important role, then he may try out certain tests of finger dexterity. If certain personality traits seem to be important, then he may try out one or more of the personality tests already available. If the individual's interest in the occupation, or in a group of occupations, seems to be important, then he may try out one of the available occupational interest questionnaires. And if the individual's past experience, his social obligations, and similar biographical data appear to be important, then the psychologist may try out biographical inventories already available. He also may have to devise tests that are entirely new.

After tests have been selected from those available, or special tests have been devised, the next move is to try them out and see how well they work in practice.

*Development of a standardized procedure for administration and scoring.* We have already (p. 56) indicated how important it is that psychological tests be given and scored in the same way for every individual tested. Anyone who uses a micrometer in a

novel fashion or who reads off the measurements in some manner of his own choosing might just as well not use an accurate measuring device at all. Not only would his own readings differ from time to time, but they would certainly not agree with those taken by somebody who knows how to use a micrometer. Likewise, in the attempt to measure anything, a standardized procedure must be used. Usually, in preparing any sort of psychological test, it is necessary to try it out on a few individuals to see the best procedure to follow, how best to score it, and so on. If it is a pencil-and-paper test, requiring answers to questions, one has to do some preliminary testing with it to weed out ambiguous questions, and those which do not differentiate between the possession or nonpossession of the qualities which the test is intended to measure.

*Administration to a large representative group.* Because a test seems to measure the processes which a job analysis suggests are important for a particular job, and because it is standardized in administration and scoring, one cannot assume that it is necessarily a good test. One must check to see whether it really does select the kinds of individuals needed.

During the First World War some psychologists decided, on the basis of a crude job analysis, that a pilot needs, above all else, to be a quick reactor and to be able to "keep his head" under conditions of stress. So they and the military authorities of the countries concerned decided, quite arbitrarily, that any candidate for pilot training who failed to reach a specified speed of simple reaction, and who changed his breathing and his hand-tremor more than a certain amount when a shot was fired unexpectedly, or an ice-cold cloth slapped unexpectedly on his head, could not be a good prospect for pilot training. This proposition seemed so reasonable (it had such "face validity") that several Allied countries used these tests to pre-select pilots. Hundreds of prospective pilots were told that their reactions were too slow or their emotional reactions too unstable for them to succeed as pilots. Then some investigators checked up to see whether there was actually any correlation between simple reaction time and tremor on the one hand and skill as a pilot on the other. They found the correlations negligible. This being the case, as many good pilots were being

eliminated as poor ones and as many poor ones were being selected as good ones. Those in charge of selecting pilot material would have been just as well off without using these reaction time or tremor tests.<sup>18</sup>

Tests must be evaluated by trying them out on a group representative of a particular occupation. There are several technical considerations in selection of this group, for it must be representative of a normal population, and so on—but we must waive this discussion in an introductory course.

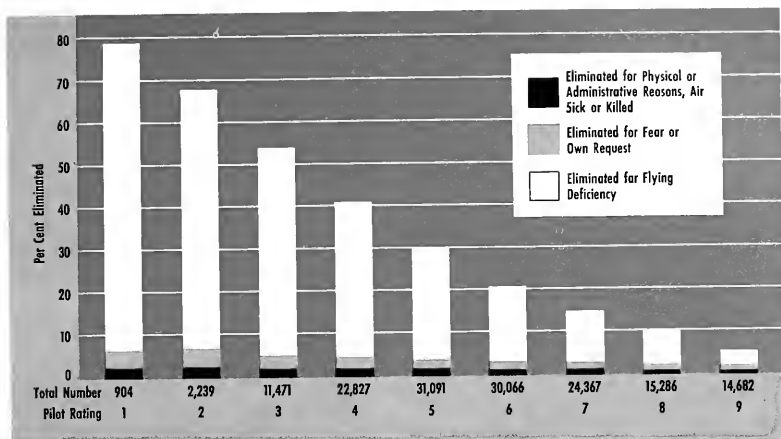
In devising selection tests for pilots, the psychologists in the Army Air Forces and Bureau of Aeronautics of the Navy Department gave their tentatively selected tests to thousands of prospective pilots and then allowed these individuals to enter training, *regardless of scores made on the tests*. In this way they could determine what would have happened had they eliminated those scoring below certain possible critical scores.

*Evaluation of test results.* To evaluate test results in terms of actual performance in an occupation, that is, to determine their validity, one must have *criteria*, indices or standards of success. In the case of pilots, the criteria might be ground-school grades, time taken to reach the solo, passing or failing, success in combat—number of planes shot down, and so on.

In the case of workers in a certain occupation, the criterion might be how quickly the requisite skills are learned, the average daily output, how many accidents the individual has, or how long he stays on the job before being fired or quitting to get another job. In the case of life insurance salesmen, the criterion might be how much insurance is sold. One must decide beforehand, of course, which of these things he wishes to predict by use of his test. The test might predict one criterion better than another. Different test batteries might be needed for different criteria.

One method widely used to determine the relation between the test results and the criterion has already been described. It is that of correlating one with the other. A high positive correlation indicates that success on the test and success in terms of the criterion selected go together.

One criterion in which those who had to select pilots were particularly interested was



**5.11 Per Cent Eliminated from Primary Pilot Training.** This covers each pilot rating in fifteen pilot classes totaling 153,000 cases. The overall elimination rate was approximately 25 per cent. (19.)

that of passing and failing the course. Anybody who entered training and failed to become a pilot was, of course, wasting his own time, wasting the time of his instructors, wasting government money, and wasting equipment. There was thus a determined effort to eliminate such waste by selecting a group most of whom would pass.

When such an arbitrary all-or-none criterion as pass-fail is used, the usual correlation techniques discussed earlier will not work. Other techniques must be used. Nevertheless, we can illustrate the selective value of the tests by graphical means. In Figure 5.11, we have the pass-fail data for approximately 153,000 young men who took a battery of selection tests and then entered pilot training.<sup>19</sup> The battery of tests included several like those already discussed in preceding pages, including the SAM complex coordinator.

The candidates' aptitude rating, in terms of overall test scores, is given at the base of the graph. The highest aptitude rating is 9, and the lowest is 1. About 80 per cent of those who made the lowest aptitude rating failed.

In short, job analysis indicated which traits

play an important role in aviation. Tests were assembled which appeared to measure such traits. These were tried out to determine their validity. Those with little or no predictive value were discarded. Finally there emerged a test battery each item of which was valid.

There was, at the time, no factor analysis of the large number of tests involved. But such factor analysis has now demonstrated that relatively few factors are being measured by a large group of tests like those used in selecting pilots. Most of the overall performance on thirty-one tests requiring movement reactions could be accounted for by three factors designed, respectively, as *Fine Control Sensitivity* (the "ability to make fine, highly controlled adjustments at some critical stage of performance,"), *Multiple Limb Coordination*, and *Response Orientation* ("rapid directional discrimination and orientation of movement patterns").<sup>20</sup> *Fine Control Sensitivity* is measured to a relatively high degree by eight different tests, including the complex coordinator; *Multiple Limb Coordination* by six tests also including the complex coordinator; and

Response Orientation by eight different tests. It is thus apparent that the same goal could be accomplished with a relatively small number of tests, each test in the battery being one which, to the highest degree, measures a particular factor. This is pointed out not to criticize the work of World War II aviation psychologists, for their job had to be done with all speed, but to illustrate again the value of factored as compared with hit-or-miss aptitude batteries.

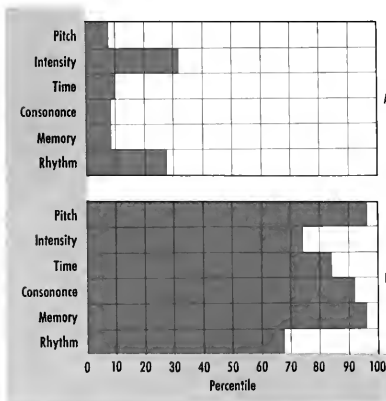
## TESTS OF ARTISTIC APTITUDES

Our discussion has centered upon scholastic, professional, and vocational aptitudes. But psychologists have also devised tests designed to predict success in music and in the graphic arts.

### Musical aptitudes

Musical aptitude tests, of which there are

**5.12 A Portion of the Musical Talent Profiles of Two Individuals.** These two people differ markedly in musical ability. **A** is an unmusical person. His percentiles for various items in the test are all below average. **B**, the musically talented man, on the other hand, is well above the average in everything. His pitch discrimination score, for example, is in the 97th percentile. (After Seashore.)



now several, are on phonograph disks. The subject sits, listens, and attempts to discriminate. In taking the Seashore Tests of Musical Talent, for example, he is tested for pitch discrimination, intensity discrimination, discrimination of rhythm, discrimination of timbre, time discrimination, and tonal memory. Instructions for the pitch discrimination tests are as follows:<sup>21</sup>

You will hear two tones which differ in pitch. You are to judge whether the second is higher or lower than the first. If the second is higher, record H; if lower, record L.

The individual then listens and reacts to pairs of tones, the second tone of each pair following the first by a very short interval. Other tests in the series are performed in a fashion somewhat similar to that described.

Actual scores on each test are converted into percentile scores. An idea of how the test differentiates extremes of musical talent is given by the musical talent profiles in Figure 5.12.

It is conceivable that a person might score high on such a test as the above, yet, because of poor finger dexterity, make a poor pianist or violinist. No matter what his dexterity, however, he could hardly hope to be successful in any aspect of musical performance without at least reasonably good pitch, intensity and time discrimination.

The Seashore Test of Musical Talent and others of its kind are widely used in schools to aid in selecting the most musically gifted. A teacher of psychology who gives the test to his classes sometimes comes across a student who, although he has never had any musical training, scores exceptionally high on the test. In schools which use musical aptitude tests, such individuals may be discovered early and encouraged to take up some musical pursuit. On the other hand, those children who have little aptitude for music can be discouraged from attempting to become highly proficient musical performers.

### Graphic art

There are several tests in this general area. Some, of which the Meier Art Judgment Test<sup>22</sup> is an example, ask the individual to judge the artistic merit of pictures. This test



**5.13** Item from the Meier Test of Art Judgment. Compare the two pictures. Note that they differ with respect to the position of the pottery. Which is better, i.e., more pleasing, artistic, or satisfying? Then look on page 490. (Courtesy Dr. Norman C. Meier.)

uses many pairs of art reproductions, as in Figure 5.13. One of each pair is an acknowledged art masterpiece. The picture with it has been changed so as to violate some important principle of art. With each pair is a statement which tells how the pictures differ. The two pictures in Figure 5.13, for instance, differ in one detail — the position of the piece of pottery. One indicates in each case which picture of the pair is a better work of art. The correct picture is that which has been judged by experts to be the better one. Total scores on this test are correlated with art grades and rated artistic ability.<sup>23</sup>

Another type of test designed to measure aptitude for graphic art is the Horn Art Aptitude Inventory.<sup>24</sup> This differs from tests like the above in that, instead of asking the individual to judge the merits of art products, it requires him to create sketches of his own. In one part of the test, there are outline drawings of familiar objects. In another part there are abstract compositions based upon given materials. The remaining part comprises a series of rectangles in each of which a few lines are given. Using these lines as a "starter" the ex-

aminee draws a complete sketch. A rectangle like those of this test is shown in Figure 5.14. Also shown is one student's sketch based upon the lines given.

Since no particular art production which an examinee may draw is right or wrong, scoring must be done by judges. These are guided in their judgment, however by sample sketches and by instructions regarding the things to look for and how to score them. Research with this test indicates that scoring, despite its subjectivity, is fairly reliable and that there is a positive correlation between test scores and instructor's ratings of performance in art classes.

These examples are illustrative of what aptitude psychologists in the field of art are doing, but tests of artistic aptitude have not been as widely used and evaluated as have our best tests of scholastic and vocational aptitude. After reviewing the various tests of artistic aptitude, a well-known authority on psychological testing has this to say: "The available tests are few in number and technically crude. At the same time, several ingenious devices and promising approaches have been developed which warrant further exploration."<sup>25</sup>

## VOCATIONAL GUIDANCE AND SELECTION

Although we have already made several references to the use of tests in guidance and selection, there is more that needs to be said. This is because vocational guidance is a much more precarious procedure than vocational selection, and what is a poor test for one purpose may have value for the other.

When an individual comes to the vocational counselor for guidance concerning a vocation, he may be given one or a number of the tests mentioned in this chapter, or other tests not mentioned here. After comparing his score with that of others on whom the tests have been validated, the vocational counselor may then be able to offer such advice as: "You have sufficiently high intelligence to do well in any of these fields, but this is the field that seems to interest you most. It is a field which requires a high degree of mechanical aptitude and the test shows that you are not handicapped there. The chances are that, if you apply yourself, you will succeed in that field." On the other hand he might have to say, "Your responses on some of these tests (intelligence) do not offer much hope of your being successful in getting an M.D. degree, but these other tests (mechanical aptitude) show that you have exceptional ability along mechanical lines, that you have a high probability of success in some industry where mechanical talent like yours is required." There are, of course, some who have little aptitude for anything, and others who have aptitude for a wide variety of vocations.

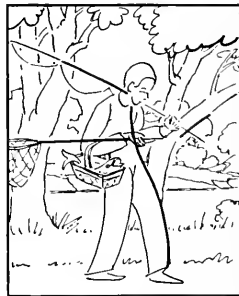
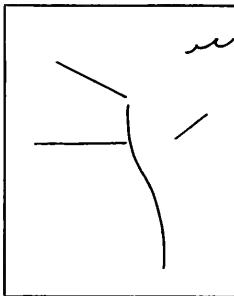
The vocational counselor does not tell an

individual that he will or will not succeed in a given line of work. There are many other things which contribute to success or failure besides those measured by tests. The availability of training and of work in various occupations also has to be considered. Sometimes there are very few jobs available along the line of one's predominant aptitudes. What the vocational counselor attempts to do, however, is to deal with possibilities and probabilities as they relate to the individual's tested aptitudes. Unless correlations between test results and actual performance are very high, any definite predictions about what individuals will do are precarious.

In the case of vocational selection, on the other hand, predictions can be made with greater certainty than in the case of individual guidance. The psychologist can say with a high degree of assurance, for example, that if individuals who fall in the lowest aptitude rating (Figure 5.11) are admitted to flight training, only about 20 per cent of them will become pilots, and if those in the uppermost rating are admitted, over 90 per cent of them will become pilots. If John Doe's score alone is involved one can say merely that he will probably pass, or fail, or that the chances are 90 in 100 that he will pass or 10 in 100 that he will fail. Observe that some in the lowest aptitude rating do succeed, and John Doe might be one of them. Observe, too, that some in the highest aptitude rating do fail, and John Doe might be one of these.

It is well to observe, finally, that even the best aptitude test used for selection purposes eliminates some individuals who, if admitted

**5.14** Item from the **Horn Art Aptitude Inventory**. Certain lines are given as illustrated, and these must be used in a complete sketch as, for example, that shown at the right. (From Horn, C. A., and L. F. Smith, 24, p. 351.)



to the occupation in question, would have succeeded. We do not know who these people are unless we give everyone a chance, but if we do give everyone a chance we waste time, money, equipment, and manpower in attempting to train a group of whom many will fail. In order to avoid this wastage, we sacrifice a few who might have succeeded. What the user of selective tests does is to determine which critical score (the score below which individuals are not admitted to the occupation) will eliminate the greatest number of potential failures while at the same time eliminating as few as possible of the potentially successful.

How high the critical score may be set depends too, upon how many individuals are needed and how many are available. Setting an aptitude rating of 9 as the standard for admittance to pilot training would eliminate all failures except a few, but very few individuals make an aptitude rating of 9. If only a few pilots were needed and the source of supply were large, such a rating might serve one's purposes. But if the number of pilots needed were high and there were only a limited number of candidates, one would have to lower his standard to a level where a sufficiently large number could be admitted.

## Summary

Aptitude is the capacity to learn readily and achieve a high level of skill in some specific area, such as scholarship, mechanics, or art. An aptitude test is designed to measure a sample of performance and, upon the basis of this, to predict possible future success. Some tests of special aptitudes are of the pencil-and-paper variety while others require actual manipulation of test materials. Many jobs require a certain group of aptitudes—or aptitude factors. Factor analysis has demonstrated that many tests in current use are measuring a relatively small group of aptitude factors. Identification of these makes it possible to arrange test batteries which measure a set of relatively pure aptitude factors. Such batteries provide profiles showing an individual's relative standing with respect to each factor. These profiles, compared with profiles representing factors required for particular lines of work, facilitate matching of men with jobs.

Aptitudes are not necessarily inborn, although some (musical, manual dexterity) may depend to a certain extent upon inborn characteristics. General intelligence is a more im-

portant aspect of some aptitudes (scholastic) than others (mechanical). Some occupations require certain intelligence factors (numerical, verbal) more than others. For most occupations one can specify a minimal intelligence level. Interests are always relevant, since the individual is more likely to succeed in occupations which interest him than in those which do not.

Aptitude tests for use in vocational guidance or selection must be standardized and evaluated for particular occupations. An important feature of the standardization procedure is to determine the relation between test performance and criteria of success in an occupation. These may be pass-fail criteria, grades, how long it takes to learn the job, or some measure of success—like work output. An aptitude test is said to be valid to the extent that it enables the investigator to predict such outcomes.

A certain degree of success has been achieved in measuring aptitudes for music and the graphic arts, but much more needs to be done in these areas.

(References and notes for this chapter are on page 546 of the Appendix.)

## Selected Readings

- Anastasi, A., *Psychological Testing*. Macmillan, 1954. Chapters 14-16 deal, respectively, with differential aptitude batteries, special aptitude tests, and tests of artistic aptitudes.
- Blum, M. L., *Readings in Experimental Industrial Psychology*. Prentice-Hall, 1952. Chapter 1 has several papers on the use of aptitude tests in predicting, for example, success in bookkeeping, supervising in an aircraft factory, and training for executive positions.
- Cronbach, L. J., *Educational Psychology*. Harcourt, Brace, 1954. Chapter 7 has a good discussion of the use of aptitude tests in education.
- Ghiselli, E. E., and C. W. Brown, *Personnel and Industrial Psychology* (2nd Ed.). McGraw-Hill, 1955. The prediction of occupational success by means of aptitude tests is discussed in Chapter 8.
- Hepner, H. W., *Psychology Applied to Life and Work* (3rd Ed.). Prentice-Hall, 1957. The use of tests to hire employees is interestingly discussed in Chapter 16.
- Karn, H. W., and B. von H. Gilmer, *Readings in Industrial Psychology*. McGraw-Hill, 1952. Chapter IV has several papers on aspects of aptitude testing in industry.
- Maier, N.R.F., *Psychology in Industry* (2nd Ed.). Houghton Mifflin, 1955. Two chapters (9 and 10) deal with the nature of aptitude tests and their use in industry.
- McFarland, R. A., *Human Factors in Air Transportation*. McGraw-Hill, 1953. Includes a great deal on selection of aircraft pilots, both military and civilian.
- Melton, A. W. (Ed.), *Apparatus Tests AAF Aviation Psychology Program*. Government Printing Office, 1947. A survey of the many tests tried out during the Second World War.
- Ryan, T. A., and P. C. Smith, *Principles of Industrial Psychology*. Ronald, 1954. Part I discusses various aspects of selection and placement including the use of special aptitude tests.
- Tiffin, J. and E. J. McCormick, *Industrial Psychology* (4th Ed.). Prentice-Hall, 1958. A great deal of up-to-date information on many different kinds of aptitude tests used in industry.



# Motivation



Needs and drives • Homeostasis • Hunger • Thirst • The sex drive and mating •  
Maternal motivation • Some stimulation drives • Personal-social motives •  
Common social motives • Motives varying with the culture • Personal motives •  
Life goals • Levels of aspiration • Functional autonomy • Force of habit •  
Unconscious motivation • Incentives and effort • Interests and attitudes •  
Summary

This chapter is concerned with what is sometimes referred to as “the dynamics of behavior.” Dynamics, a term taken over from the physical sciences, refers to the energies or forces which produce motion in physical bodies. The appropriateness of this term, as applied to the motivation of behavior, can be seen from the fact that our concern here is with what moves the organism to do what it does. We are concerned not so much with what the organism does, nor with how it accomplishes what it does, but with *why* it acts as it does. This interest, as will soon be apparent, leads us to infer the presence of internal energizers or driving forces which activate the organism and influence its responsiveness to external stimuli.

In terms of its derivation, the word *motivate* means to move, to activate. In this general sense, anything that initiates activity, whether external or internal, is motivating. In psychology, however, the terms *motivation* and *motive* refer to activation from within the organism. Thus motivated behavior is internally activated, or at least modified by, internal conditions. A motive, therefore, is some internal activator or modifier.

The general significance of what is meant by motivation can be made plain by reference to the activity of a puppet. The puppet is a static mechanism, incapable of initiating its own activity. It moves only when its strings are manipulated. Its

movements are forced upon it. It is completely under external control. Moreover, every movement is predictable from a knowledge of how the puppet is constructed and the forces applied to it. In view of these facts we say that the puppet is without motivation. We attribute no motives to it.

Contrast with this the behavior of living organisms. The simpler organisms act in many respects like puppets. They exhibit forced movements, known as *tropisms*, in which the whole body is turned toward or away from certain stimulating situations. Thus the cockroach runs from the light and a moth is attracted to it. Moreover, all organisms with a nervous system exhibit partial reactions — *reflexes* — which are equally puppet-like. In us, for example, there is a reflex pupillary response to changes in illumination, a reflex kick of the foot (knee jerk) when the patellar tendon is struck, and a reflex gagging when the doctor applies a spatula to the back of our tongue. We have, in fact, many such reflexes.

Because they are puppet-like, neither tropisms nor reflexes are said to be motivated. In other respects than in their tropistic and reflex behavior, on the other hand, all animals have a certain degree of autonomy. They are, that is to say, self-regulating. This is so for a number of reasons, as we will now see.

All animals undergo internal physiological changes related to the necessities of life — changes associated with such needs as for liquid, nourishment, and elimination. Through their effects on the nervous system, these physiological changes initiate relevant activities such as drinking, eating, and eliminating. They also influence receptivity to certain kinds of stimulation. The odor of food, for example, is especially attractive to the hungry organism.

It is customary to refer to the necessities of life as *physiological needs* and to the related conditions which motivate behavior as *physiological drives*. There are, however, some inborn drives which have no direct relation to the maintenance of life. The sexual urge, for example, need not be satisfied in order that the individual may survive. It does, of course, have significance from the standpoint of perpetuating the race. There are some other drives which, although important for survival, and perhaps more or less instrumental in satisfying physiological needs (like the need for food) are of a quite different order from hunger itself. Organisms are so constituted, for example, that they are especially responsive to changes in their environment. Instead of responding passively, they actively explore and examine their surroundings.

Other inborn drives which have no direct relation to physiological needs, are those involved in emotional motivation. A frightened organism may run away or, if cornered, attack an aggressor. The organism that has experienced painful stimulation may become anxious and, as a result, avoid certain situations when avoidance is possible. These and other emotions have much to do with our own responses to the world about us.

Still another reason why organisms are different from puppets is that they learn. Their nervous system is modified by what happens to them. They learn where and how to satisfy their needs and they act accordingly. They do not merely wait for something to happen. Human beings also develop attitudes, interests, aspirations, and life goals. They pursue their long-range goals despite environmental distractions and frustrations. Indeed persistence in a given direction is one of the clearest signs of motivated behavior. The man of Henley's *Invictus* who says, "I am the master of my fate: / I am the captain of my soul. . . ." is a "self-starter" and shows persistence of a high order. The fact that he thinks himself master of his own fate, whether or not this is ultimately so, is itself motivating and it may have a very significant influence upon his conduct.

At birth and for some time thereafter we are completely dominated by physiological

motives. We sleep most of the time, but wake and take in nourishment when hungry, protest noisily against irritating or painful stimuli, and eliminate waste products as they accumulate. These primitive motives, which we share with other animals, are represented in Freudian terminology by the general term *id*. According to Freud, the *id* is "the oldest of mental provinces," which "contains everything that is inherited, that is present at birth, that is fixed in the constitution," including the drives "which originate in the somatic organization."<sup>1</sup>

Animals and human infants are almost completely dominated by their physiological motives. Although we retain such motives, their expression undergoes considerable change as we grow older. Animals satisfy them directly, as soon as they arise. When hungry they seek food where they have learned to find it and they usually rend, and tear, and guzzle without reference to the needs of others or rules of conduct. At appropriate times and seasons they seek mates, and again they are dominated completely by the exigencies of the moment. As excretory needs arise, they satisfy them immediately, wherever they happen to be. When animals are frustrated by others, they often fight and kill.

Human beings, on the other hand, learn to behave in ways decreed only in part by their biological heritage and the immediate situation. Beginning soon after birth, they reality-test and, as a result, develop a self, an *ego*. Some animals below man perhaps also develop an ego on this basis, but the *id* retains a major place in their motivation. Human beings also take on the ways of others, even to the extent of acquiring moral principles; in short, a conscience, or *superego*. They are increasingly modified by customs, traditions, and man-made laws. Consequently, even though human beings have the same physiological needs as other animals, they come to behave more like men and women than like animals. In Freudian terms, the ego and superego assume dominance over the *id*.

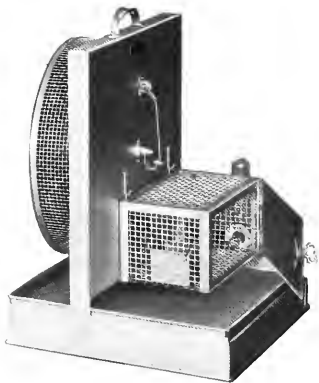
In this transformation of animal into human nature, a significant role is played by social influences, and especially those dependent upon one's culture. The life of all human societies is organized around the problem of satisfying physiological needs. All agricultural activities are in one way or another linked with the need for food. Many of the most rigid social customs have to do with regulation of sexual activities. There are definite customs for the control of excretory needs. Various measures to protect the individual from injury have been instituted. There are prescribed ways of settling disputes so that angry men are restrained from attacking their fellows.

## NEEDS AND DRIVES

Physiological needs are such necessities of life as food, water, warmth, and sleep. We have them because of the way we are made. They come with our biological heritage, which is to say that they are inborn, or innate. These needs are in sharp contrast with the personal-social needs to be considered later, for the latter are dependent upon personal experience and are influenced by social contacts, including the cultural ones which comprise our social heritage. Personal-social needs are, as we say, "acquired" rather than innate.

Some physiological needs give rise to inner conditions which appear to *drive* the organism to activity. This activity persists until the need is satisfied or until weakness or death occurs. Take, for example, a rat deprived of food for twenty-four hours or so. It becomes excessively active. If it is given access to a device like that in Figure 6.1, it enters the drum and runs. Revolutions of the drum, read from a counter, indicate the distance run.

In one investigation, rats were put on a diet which reduced their weight. These animals were given access to the revolving



**6.1 A Revolving-Drum Apparatus for Studying Activity.** The rat lives in the cage at the right of the apparatus. When it runs in the revolving drum at the left, the revolutions in either direction are recorded by the cyclometer. There is a sliding door, not seen in the figure, by means of which the rat may be made to remain in the revolving drum or prevented from entering it. A sliding tray under the apparatus collects the debris. (Courtesy George H. Wahmann Mfg. Co.)

drum one hour daily. Observe, in Figure 6.2, that the resulting activity was a function of the loss of body weight, and, presumably, of the degree of hunger and thirst. The correlation between the per cent of normal body weight and the number of revolutions of the drum was  $-.99$ , an extremely high relationship.<sup>2</sup> Another investigation which used the same method, but one in which the normal body weight was gradually restored, showed a gradual decrease in activity level as the rats approached their normal weight.<sup>3</sup> It is important to note that these activity changes occurred in an environment that was as constant in lighting, temperature, and other characteristics as the investigators could make it. The internal conditions responsible for such obviously driven behavior are said to be *physiological drives*. In the present instance, we speak more specifically of a *hunger drive*.

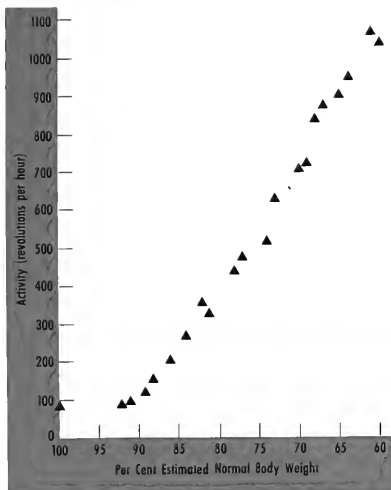
Here are some further examples. A rat in

heat is very active. In a revolving drum, it may run the equivalent of fifteen or more miles in a day. On days when the rat is not in heat, even though external conditions are the same, it runs very little.<sup>4</sup> We say, in this case, that a *sex drive* is responsible for the excessive activity.

Now let us examine a quite different activity, nest-building. If strips of paper are available and the temperature falls, the rat actively engages in nest-building and the intensity of such activity (as determined by the pieces of material used) increases as a function of the drop in temperature. As the temperature rises, however, nest-building declines and, when the temperature is normal, stops altogether.<sup>5</sup> Here is an externally stimulated drive, but one which depends upon the need to maintain a normal body temperature. This is commonly called a *nest-building drive*, although one might just as appropriately call it a *temperature drive*.

We mentioned the temperature drive chiefly to set the stage for discussing another in which, regardless of the external temperature, the rat becomes excessively active in building nests. This is a rat that has just recently given birth to a litter. Some condition associated with having given birth drives her to build nests, in which she puts the young, even though, under other conditions, she would build no nests at all.<sup>6</sup> The fact that she persists in this activity even when the temperature is very high, is evidence enough of some inner condition which has the characteristic of a drive. We speak, in this case, of the *maternal drive*.

The concept of drives is a useful one for purposes of discourse, but the actual condition which impels the organism—what is sometimes referred to as the *drive state*—is often difficult or impossible to specify. A large amount of research on motivation is aimed at discovering what hunger is, physiologically. Similar research is focused upon thirst, sex, and other inborn drives. Interestingly enough, however, when we are able to specify the precise biochemical and neural basis of hunger, thirst, and other drives, we will have no further need for the general term, *drive*. The specified condition will be cited to account for food-seeking, drinking, mating, and so forth. Progress in this direc-



**6.2 Activity as a Function of Weight Reduction.** Observe that as the per cent of normal body weight decreases the activity level (number of revolutions per hour) increases. (From Moskowitz, M. J., "Running-Wheel Activity of the White Rat as a Function of Combined Food and Water Deprivation," *Journal of Comparative and Physiological Psychology*, 1959, 52, p. 624.)

tion is being made, and we shall learn some of the details presently. But much is yet to be discovered and the concept of drive is still a useful one.

As we have seen, a physiological drive is named in terms of (1) the sort of deprivation which gives rise to it, (2) the physiological processes involved, insofar as these are known, and (3) the culminating activity, i.e., that which alleviates the need or which is relevant to such alleviation. In the case of hunger, for instance, the drive is aroused by depriving the animal of food, or at least cutting down on its rations. Among various known conditions which underlie hunger are stomach contractions. The appropriate culminating activity — that which satisfies the organism's need — is eating.

It is possible to regard the physiologically driven organism as in a state of physiological disequilibrium. Then the culminating act, such as getting food, is thought of as compensatory — as restoring equilibrium.

The tendency of motivated behavior to maintain a balanced condition within the organism is called *homeostasis*. As one physiologist put it, "The living being is an agency of such sort that each disturbing influence induces by itself the calling forth of compensatory activity to neutralize or repair the disturbance."<sup>7</sup> He had in mind such compensatory activities as the following: restoration of injured tissues by white blood cells; the maintenance of a constant body temperature by sweating, slowing down of activity, and seeking the shade; and the maintenance of a normal carbon dioxide level in the blood by faster and deeper breathing when the air is deficient in oxygen. It is interesting to observe, in the latter connection, that Indians living in the Peruvian Andes at a height of 10,000 to 11,000 feet "have tremendous chests that allow them to take in enough oxygen for the heavy work they do."<sup>8</sup>

The concept of homeostasis is relevant to certain physiological drives, but not to others. The tension built up when one wants to relieve his bladder is dissipated quickly when urination occurs. The drowning person's struggles cease when he is rescued and can breathe again. Similarly, rest and sleep revive the fatigued organism. In certain other instances there are difficulties with a homeostatic interpretation, especially if considered from a purely physiological standpoint. As the following statement by an outstanding investigator of sex behavior indicates, it is difficult even to see how copulation could be considered an example of homeostatic response.

The individual deprived of sexual outlet does not perish, regardless of the length of time involved. No genuine tissue or biological needs are generated by sexual abstinence. It used to be believed that prolonged sexual inactivity in adulthood resulted in progressive accumulation of secretions within the accessory sex glands, and that nerve impulses from these distended receptacles gave rise to sexual

urges. Modern evidence negates this hypothesis. Work in my own laboratory has shown that male animals which have been surgically deprived of the glands in question continue to display unmistakable signs of sexual arousal and potency. Furthermore, homologous structures in the female are undeveloped, and yet, if we are to believe Professor Kinsey and other experts, sexual motivation is not exclusively a masculine prerogative.<sup>9</sup>

Since the concept of homeostasis was first propounded, however, some psychologists have come to use it as synonymous with compensatory behavior of any kind.<sup>10</sup> It might then be said that the *psychological tension* associated with sexual desire, even on a purely symbolic level, as when the person is preoccupied with thoughts of sex, is relieved by sexual activity. Later we will observe further use of the homeostatic concept in relation to the maintenance of self-esteem by so-called "ego-defensive" or "ego-compensatory" activities. This use of the term *homeostasis* divorces it almost completely from its original physiological meaning, as described above.

### HUNGER

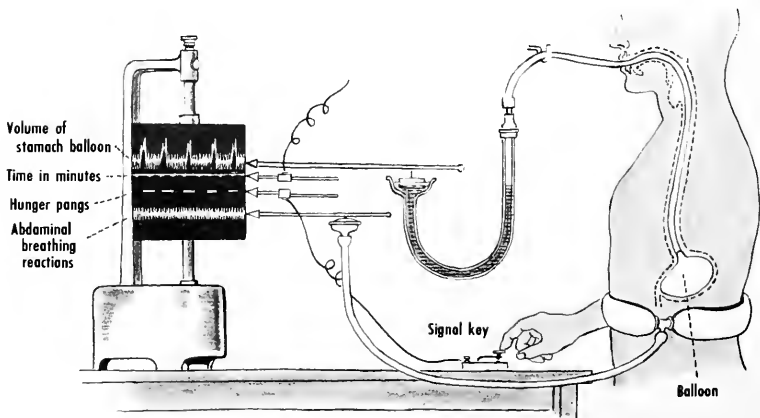
When deprived of food for a long time, human beings report aching or gnawing experiences known as *hunger pangs*. These are

correlated with muscular spasms of the stomach walls. This may be shown by using subjects who have been trained to swallow a small balloon with rubber tubing attached. The balloon is inflated in the stomach and the rubber tube then connected to a kymograph recording mechanism (Figure 6.3) so that each spasm of the stomach muscles causes a mark to be made on the smoked drum. In addition, the subject is told to press on a key whenever he feels hunger pangs. A mark is thereby made on the drum just below the record of stomach activity. The subject's abdominal breathing is also recorded, so that the investigator may decide whether the spasms represented in the record are due to stomach or to abdominal movements. The record shows that hunger pangs coincide with stomach contractions, but are unrelated to movements of the abdominal muscles.

### Hunger and blood chemistry

Various lines of evidence suggest that hunger pangs and stomach contractions both depend upon blood chemistry. In the first place, the stomach may be removed, or nerves between it and the brain severed, yet without destroying the hunger drive.<sup>11</sup> In the second place, if the blood sugar level is lowered by injections of insulin (the hormone given diabetics to control carbohydrate

**6.3** The Relation Between Hunger Pangs and Stomach Contractions. Observe that the peaks in the upper record are quite independent of abdominal breathing. They are produced by spasms of the stomach itself, and are correlated with signals given by the subject when he experiences hunger pangs. (After Cannon.)



metabolism), stomach contractions and hunger pangs are induced. When dextrose, which raises the blood sugar level, is given, these contractions and hunger pangs cease.<sup>12</sup> In the third place, if blood from a starved dog is injected into a normal dog, the stomach of the injected animal shows the kind of contractions found in hunger. Injection of blood from a well-fed animal, on the other hand, stops the stomach contractions.<sup>13</sup>

The fact that injection of blood from a starving dog into a normal one elicits stomach contractions suggests that lowering of nutrient reserves releases specific chemical activators (hormones) into the blood stream and that these, through their effect upon the nervous system, are responsible for both the stomach contractions and the hunger pangs.<sup>14</sup>

### Other physiological aspects of hunger

Food may be placed in the stomach directly via a fistula, which is a long tube attached at its lower end to the inside of the stomach. When milk (20 milliliters) is injected in this way, the hungry rat acts as if its hunger is reduced.<sup>15</sup> The rate at which it presses a bar to get food (see Figure 10.2) drops significantly. If a stomach balloon like that of Figure 6.3 is inflated with an equal amount of liquid, the rate of responding is also reduced, but not as much as when milk enters the stomach. Thus milk in the stomach and stomach distension both reduce the hunger drive, but milk is more effective.

Is the rat "fooled" by stomach inflation? Apparently not, for this is ineffective as a "reward" in learning situations. Rats were trained in a T-shaped maze to turn in one direction or the other at the upper end of the T. If they turned in the proper direction, 14 cc of milk was injected into the stomach as they entered the goal box. They learned this habit. By contrast, a comparable group of rats subjected to a 14 cc inflation of a stomach balloon learned to *avoid* the side which produced such distension of their stomach. Distension of the stomach was therefore a deterrent rather than an incentive.<sup>16</sup>

Why did food and stomach distension have such diametrically opposed effects? The answer may be that inflating a balloon in the

stomach produces nausea, which would reduce hunger and hence the rate of response in the bar-pressing situation and also act as a deterrent in a situation where it could be avoided.<sup>17</sup>

Other investigations have compared the relative effectiveness of milk taken by mouth and milk injected into the stomach via a fistula. One comparison used bar-pressing; the other used learning to make the appropriate turn in a T-maze.

Under certain conditions, the details of which need not concern us here, a hungry rat's rate of responding in a bar-pressing situation remains relatively constant. Since an increase in the amount of food received decreases the rate of response, the latter is taken as an indication that the drive has been reduced. In the comparison of interest to us here, a given amount of salt solution was injected into the stomach as a control and the effect of this was compared with that of an equal amount of milk injected into the stomach. With salt solution, the rate of response dropped to about 12 per minute, with milk to about 7 per minute. Thus milk reduced the hunger drive more than salt solution. Milk in the mouth, however, was even more effective. It reduced the rate of responding to about 5 per minute.<sup>18</sup>

The finding that milk given by mouth has a greater effect than milk placed directly into the stomach is supported by results with the T-maze, for the milk-by-mouth subjects learned the habit much faster than those given stomach injections of an equal amount of milk.<sup>19</sup>

The preceding results are of considerable interest. On a long-time basis, of course, the *need* for food can be satisfied only by food. But it takes time for food to be digested, to change the constitution of the blood, and to alleviate the need, i.e., restore equilibrium. If all of this were necessary in order to reduce the hunger drive and to stop the rat's eating, the effects would be too long delayed, and the animal would over-eat. Moreover, hunger reduction on such a homeostatic basis would come too late to serve as a reward in learning, as when the rat in the T-maze learned to go in the direction where milk was obtained. What is of special interest, therefore, is the fact that milk in the mouth and milk in the

stomach reduced the hunger drive almost immediately. Apparently there is something about the taste, smell, or feel of food which itself rewards a hungry animal. Even the injection of milk into the stomach via a fistula appears to reduce the hunger drive almost immediately rather than after a long enough period for the physiological need to be alleviated.

### Experiments on semistarvation

An excellent opportunity for scientific research on hunger occurred during the last World War when thirty-two conscientious objectors volunteered to serve as subjects in experiments involving semistarvation. Scientists at the University of Minnesota<sup>20</sup> studied these men for three months under normal conditions. Each man was then systematically dieted for a period of six months, during which his weight was reduced by approximately 25 per cent. A three-month period of rehabilitation was then instituted.

The experimenters investigated many aspects of health, general physiology and psychology. Large individual differences appeared. Among the outstanding psychological effects were feelings of weakness, hunger pangs, irritability, loss of interest in sex, and unusual interest in cook books and food illustrations. The hunger drive became all-important. While there was no reduction in general intelligence as measured by tests, the general intellectual life of the subjects was channelized by their need for food. It is reported, for example, that "The intensive preoccupation with food made it difficult for the men to concentrate upon the tasks they had intellectually decided they would work on. If a man tried to study, he soon found himself daydreaming about food. He would think about food he had eaten in the past; he would muse about opportunities he had missed to eat a certain food when he was at this or that place. Often he would daydream by the hour about the next meal, which was not very far away."<sup>21</sup> The men wrote notes to themselves as reminders of things to be done. There was general apathy. Poor manners appeared, such as eating noisily and licking plates. Some men showed a deterioration of ethical control; as, for example, by

buying food or, in one case, stealing it. "Most of them felt that the starvation had coarsened rather than refined them, and they marvelled at how thin their moral and social veneers seemed to be."<sup>22</sup>

Thus we see how hunger tensions may subvert an individual's higher motives and intellectual activities. The outcomes of this research are of practical as well as theoretical value, for they give understanding and provide guidance for those who have the task of rehabilitating the world's semistarved populations.

### THIRST

When deprived of water over a period of hours, an organism becomes excessively active. This is true even when all other needs are satisfied. If water becomes available, drinking terminates the activity.

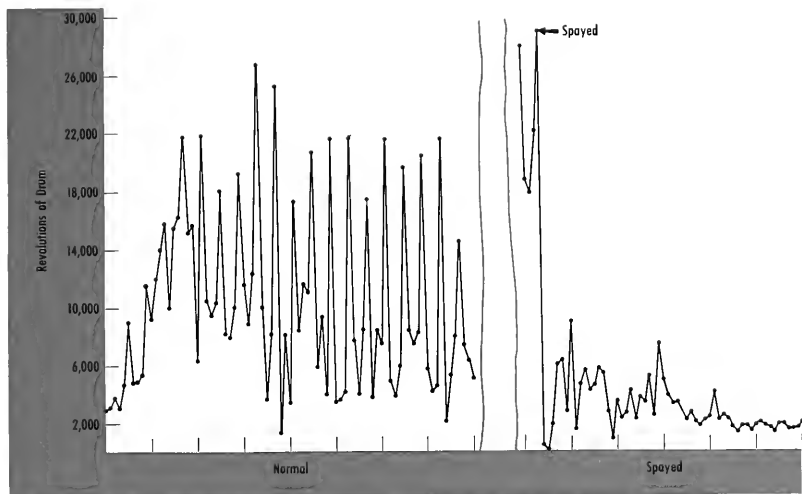
What provides the drive behind water consumption? According to a well-known theory, the drive comes from dryness of the mucous lining of the mouth and throat.<sup>23</sup> When the organism is deprived of water over a period of several hours, the mouth and throat indeed become dry, thus reflecting dehydration of body tissues in general.

When water is placed in the stomach directly via fistula, a period of several minutes must elapse before the thirst experience ceases. This suggests that the water, in order to be effective in removing thirst, must get into the tissues sufficiently to remove the dryness of mouth and throat. On the other hand, merely wetting the mouth temporarily removes the thirst experience.

Dogs subjected to different degrees of water deficit drink an amount of water directly proportional to the known deficit.<sup>24</sup> But such an accurate "estimation" by the dog of its need for water is hard to explain in terms of dryness of the mouth and throat alone. The first mouthful would wet the mouth and throat, removing the condition which might otherwise provide a dog with a guide to the amount needed.

As in the case of hunger, some unknown condition or conditions, aroused by a state of deficit, must regulate both thirst and water consumption. The most important single condition appears to be cellular dehydration.





**6.4** Activity Level as Measured with a Revolving Drum. Each succeeding dot in the curve represents a day. Observe that the normal rat has a peak level of activity every fourth day. The age range is from 59 to 129 days. At the right, drawn to the same scale, is shown the drop in activity level that occurred when a normal rat was spayed. The record began at 117 days and ended at 177 days. A revolving drum was shown in Figure 6.1. (Arranged from Richter and others.)

### THE SEX DRIVE AND MATING

The physiological bases of sexual motivation are well known, largely through research on animals. This has shown that there are certain basic similarities in the sexual motivation of human beings and other organisms; but it has also revealed important differences.

#### The sex drive

Hormones secreted by the *gonads*, the testes in males and the ovaries in females, are responsible for sexual motivation. The male sex hormones (*androgens*) come from the testes. Castration cuts these off at their source. When this occurs prior to puberty there is no sex drive.

The ovarian hormones are known as *estrogens*. When the ovaries are removed prior to puberty, the typical female characteristics, including periodic heat, fail to appear.

If mature female rats are placed in cages

with revolving drums attached, as illustrated in Figure 6.1 (p. 140), they spend a great deal of time running. Every fourth or fifth day, activity reaches a peak and, as we said earlier, it is not unusual for the animal to run the equivalent of fifteen or more miles. This periodic activity, with relatively inactive days followed by a day of great activity, begins at around the time of puberty and ceases at the menopause. It is on the day of greatest activity that the female is especially receptive to mating. Its own activities at this time (see p. 140) are such as to excite sexual activity in the male. If the ovaries are removed before the time of puberty, however, such behavior never develops. Activity is greatly reduced, there is no cycle, and mating fails to occur.<sup>25</sup>

When a mature female rat is spayed, her activity drops to a low level, as illustrated in Figure 6.4. The activity cycle is obliterated; and sexual behavior ceases. This situa-

tion may be remedied by ovarian grafts or by periodic injections of ovarian hormones.<sup>26</sup>

It is thus apparent that estrogenic hormones activate the female rat and provide a high level of sexual motivation. In human females the same hormones are present, and their production becomes greatly accelerated at puberty. They account in large measure for the development of breasts and other aspects of the typically female physique, but their effect on sexual motivation is problematical. They may affect feminine interests in subtle ways, and make them more susceptible to male advances. There is, however, no obvious emergence of sexual motivation such as animals characteristically exhibit.

One possible explanation of this difference between animal and human motivation is that purely physiological motivation has been suppressed in the latter by cultural influences, which of course play no part in animal behavior. Fear of pregnancy, of disease, and of breaking the taboos are prominent among such restraining influences.

Research with animals, as well as clinical observations on human beings, have demonstrated that sexual motivation, while most intimately related to functions of the gonads, is also influenced by other endocrine glands. The pituitary and adrenal glands are implicated. The pituitary gland plays a key role. Inadequate functioning of its anterior lobe (Figure 9.4, p. 240) disturbs the functioning of the gonads and other glands. One hormone from the anterior pituitary (ACTH) stimulates the adrenal cortex, which produces cortisone. Sometimes the adrenal cortex is itself defective. It puts out no cortisone, or insufficient amounts of it. When there is inadequate cortisone, for whatever reason, one of the effects is loss of sexual desire. This may, however, be but a reflection of the general disturbance of bodily metabolism in individuals thus affected. General vigor, as well as sexual desire, may be restored by administration of ACTH, or cortisone.<sup>27</sup>

When removal of either male or female gonads occurs in mature human beings, there may be little influence upon further sexual activity. Continuance of sexual motivation under these conditions is probably due to retention of interests and habits which, while they originally developed under the influence

of the gonads, are no longer dependent upon secretions from these glands. It is interesting to observe, in this connection, that men and women whose gonads have degenerated during middle or late life (the menopause in women) usually continue to participate in sexual activities. Kinsey reports that women who have gone through the menopause often increase their sexual activity, perhaps because they no longer fear pregnancy.<sup>28</sup> In those cases where a decline in sexual vigor does occur, it can now be revived through injection of hormones, estrogenic for women, and androgenic for men.<sup>29</sup>

The human sex drive varies considerably both in its intensity from one individual to another and in the directions in which satisfaction may occur. Repressive influences (such as ideas that sex is evil, or dirty) sometimes lead to absence of sex interests and inability to engage in sexual activity, despite the fact that the individual is structurally normal. Frigidity (in women) and impotence (in men) represent this low tide in sexual drive. At the other extremes are nymphomania (in women) and satyriasis (in men). Individuals thus affected, because of excessive glandular secretions or excessive social stimulation involving sex, have an unusually strong sex drive.<sup>30</sup> Kinsey's studies, based upon questionnaire data, suggest that there is a very large variation in frequency of male sexual outlet. His tables indicate a variation of from 0 to over 29 outlets per week.<sup>31</sup>

Variations in the direction of the sex drive often begin to develop in childhood. Just as hungry organisms continue to seek out that which satisfies their hunger, so do they seek a repetition of those acts which have in the past resulted in sexual satisfaction. It often happens that a child whose sex urge has already made its appearance stimulates itself sexually, is stimulated sexually by another member of the same sex, or receives sexual stimulation from some object or situation. The satisfaction obtained from such stimulation may lead the individual to seek a repetition of it. Continued into adulthood, unusual directions of sexual satisfaction may prevent the kinds of sexual release sanctioned by society. The individual is then regarded by the group (and often by himself) as abnormal or perverted. Similar "perversions" often occur in

animals (and especially in the higher ones), but they are more frequent and more varied in man.<sup>32</sup>

### Mating

The physiological needs of many organisms are satisfied in ways characteristic of the species, ways which individuals do not have to learn. Thus one male rat mates in approximately the same manner as any other, but in a different manner from dogs, cats, or monkeys. Moreover, it mates in the same stereotyped way—that is, in the same position and with the same sequence and pattern of movements—whether it has observed other rats mate or whether it has been reared entirely by itself. The female rat also has a stereotyped unlearned mating pattern.<sup>33</sup>

Such complicated patterns of behavior, which are universal in the species and which do not have to be learned, are called *instincts*. Both male and female rats may thus be said to have a mating instinct.

Mating in monkeys is less stereotyped than in lower mammals like the rat, dog and cat. When the level of the higher apes is reached, it is doubtful whether a mating instinct, as defined above, any longer exists. The chimpanzee, like the rat, has a strong *sex drive*, and it of course has reflexes, like erection and ejaculation, which play a part in the act of mating and which are unlearned. But a universal stereotyped mating pattern is absent. The pattern which finally emerges must be learned by the individual animal. It is thus a *habit* rather than an instinct.

Studies carried out with chimpanzees observed from an early age until adulthood, show that mating develops in an exploratory, trial-and-error manner out of play behavior. In one study, five sexually naïve adolescent females were paired with an equal number of sexually naïve adolescent males.<sup>34</sup> The chimpanzees lived together as youngsters, but prior to puberty they were segregated by sexes. Then they were brought together again, and in all possible pairings. This occurred at least one year after the females had menstruated, and at a time when they were in the period of greatest sexual receptivity. There were over 100 observations of such pairings. Normally there would have

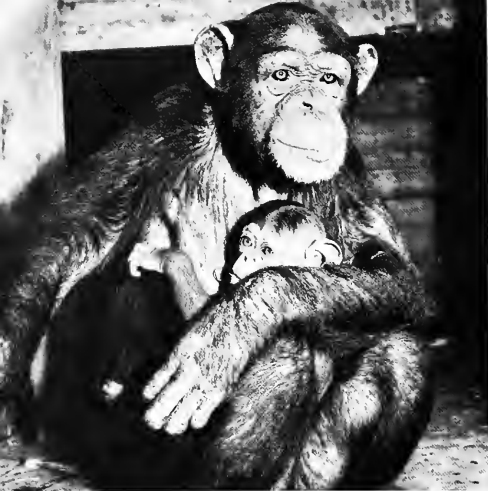
been at least 200 matings. Among these inexperienced chimpanzees, however, there were no copulations at all. Nevertheless, a great deal of activity occurred. This included individual and mutual grooming (picking at each other's skin), aggressive acts, play-fighting, wrestling, playful slapping, and playing tag. Although no mating occurred, "there was a great deal of social behavior, including most of the constituent acts which enter into the mating pattern." These observations are in complete agreement with others made on chimpanzees. The pattern of behavior which finally develops, including the position used, differs from one animal to another, and even in the same animal from time to time.

Human beings also learn to mate. Such learning is based on hearsay, observation, and trial-and-error, as well as direct instruction. The varieties of human sexual behavior found in different cultures have been described by anthropologists.<sup>35</sup> In many respects, the pattern most commonly adopted is culturally rather than biologically determined. Volumes have been written on the varieties of sexual behavior in our own society, as revealed by interviews and clinical reports. Books have been written for the sexual education of newlyweds. If we possessed a mating instinct, there would be little or no variety to mating behavior and we would not need books or other sources of information on how to mate.

It is apparent that man has an unlearned sex drive and unlearned sexual responses of the reflex variety, but we may question whether he has a mating instinct in any strict sense of the term.

### MATERNAL MOTIVATION

What has been said about a sex instinct applies equally well to maternal behavior. The rat mother, when she gives birth to a litter, exhibits a clear-cut behavior pattern even more complicated than the sexual pattern. She licks the newborn, bites off the umbilical cord, eats the placenta, builds a nest out of any available debris, retrieves the young, places them in the nest one by one, and then crouches over them. Prolactin, a hormone from the anterior pituitary gland, plays an important role in motivating such



## 6.5 Maternal Behavior in a Chimpanzee.

Maternal behavior at all approaching that of human beings does not appear until the primate level of evolution is reached. In chimpanzees, one of the higher apes, much of the maternal behavior resembles that of human beings. (Lilo Hess, *The Three Lions*, Inc.)

behavior. This hormone stimulates even virgin rats to retrieve and care for young rats.<sup>36</sup>

The maternal drive is present in all rats that have given birth to a litter. So, also, is the stereotyped pattern involved in care of the young. This is essentially the same whether the litter is the rat's first or whether there have been earlier litters. It is essentially the same, moreover, whether or not a rat has had opportunities to observe maternal behavior in other rats. For these reasons we are justified in regarding the behavior as unlearned and in speaking of the rat's *maternal instinct*.

As the primate level is approached, maternal behavior not only becomes more "human" (Figure 6.5) but also increasingly variable. In human beings, neither the maternal drive nor maternal behavior itself is clearly inborn. Prolactin is secreted by the anterior pituitary

gland as in the rat, and other physiological conditions associated with birth are quite similar to those found in the rat, but the results of these are unpredictable.

The problem of human maternal motivation and maternal behavior has various aspects which should be kept clearly in mind. There is a great difference between wanting to have children before they are born and wanting to keep them and care for them afterwards. Another aspect of the problem is how the child is cared for. Does this care involve an inborn behavior pattern, as in animals like the rat?

The desire for children is by no means universal. Many women, even after they are pregnant, wish, for various reasons, that they were not. Some want children only because their husbands do, others because they want something to occupy their time, and still others because they think that a woman should have children. These are only three of the many reasons, apart from mother love as such, which women give for having children.<sup>37</sup>

Many women who say they do not desire children nevertheless display mother love after the child has arrived. However, there are many possible reasons for this other than, or in addition to, the physiological motives.

According to one study there is a close relation between maternal interests and early preoccupation with dolls and babies. Here, for example, are the data for two women, the first rated as "highly maternal" and the second as relatively "nonmaternal."

(1) As a young child, her favorite game was taking care of dolls, dressing them, putting them to bed. She played with dolls until age fourteen or fifteen. She used to make visits among her mother's friends to take care of their babies. When she thought of being a mother, she hoped to have six children, and have them as soon as possible. When she saw a pretty baby on the street, she had a strong urge to take it in her arms and hug it. She was a "baby-carriage pecker" before, as after, marriage. In her relations with men she was always maternal; much more, she said, than they liked.

Actually, she had four children and is now pregnant with her fifth. She had a nurse for

her first child and was miserable, she said, because she couldn't take full care of it. She hated the hospital rule of not having the baby in her room. She fed all her children at the breast, and with ease. She had a copious supply of milk.

Her husband stated that she really spoiled the children; that every so often she fought against this tendency and became severe, to protect them from her spoiling. But the children "see through it."

(2) Never played any "maternal" games in childhood, nor played a maternal role to another child. She had very little interest in dolls and stopped playing with them when about age six. When she saw a pretty baby on the street, she was not at all interested. As an adolescent, she never indulged in the fantasy of being a mother and having children. She was ambitious to get married, but never thought about having children. As a mother she has felt quite incompetent. She took her children off the breast after two weeks, because she didn't like it; she felt like a cow, she said. She still hates the physical care of children, though she is a dutiful mother and rather affectionate. She never was maternal towards men. Her interests have always been feminine, and she has been quite popular with men.<sup>38</sup>

What about the pattern of human maternal behavior? There is no universal pattern, unless it be that of feeding the child on the breast when such feeding is possible. Except for this, the pattern differs widely. The way in which children are handled is an aspect of maternal behavior which varies from one culture to another. Actually, there is so much to maternal care besides the nursing pattern, all of it apparently learned, that it is doubtful whether one is justified in speaking of a maternal instinct in human beings. The fact is that human mothers, even with their observations of their own parents and others to help them, are often so ignorant of how a child should be cared for that they must receive special instruction through books or by attendance at clinics.

In this chapter we have mentioned a number of inborn physiological needs, some clearly homeostatic and all directly or indirectly involved in survival of the individual or his race.

Among these are the need for food, water, oxygen, elimination of waste products, sleep, warmth, activity and, particularly of racial significance, the need for reproductive and maternal activity. In addition to such obviously physiological needs there appear to be others which, while also inborn, have less urgency for the individual or the race and lack any clearly discernible drive states. These needs, or more particularly the drives assumes to be associated with them, are referred to by some as *non-homeostatic*, which is hardly a good designation because some of the other drives are also nonhomeostatic, at least in a physiological sense. For want of a better term, we will call these *stimulation drives*.

### SOME STIMULATION DRIVES

What we have elected to call "stimulation drives" are based upon an alleged "need for affection," a "need for stimulation," and a "need to explore and manipulate." All three are alike in that they imply a reaching out for various kinds of external stimulation.

#### Is there a need for affection?

It has been claimed that infants need to feel the warmth of the mother's body, to be cuddled, fondled, and petted and that failure to satisfy this need has dire consequences both for physical and psychological development.<sup>39</sup> Influenced by this viewpoint, a prominent anthropologist declared in a public lecture that babies should remain in bed with the mother after birth instead of being removed to a nursery because the latter procedure robs them of the need to feel the mother's warmth and to be hugged and fondled by her.<sup>40</sup> It has been claimed, in fact, that when the infant's own mother is not available, a substitute mother should be provided to cuddle it. Some institutions use volunteers to "mother" children in the above ways for given periods daily.<sup>41</sup>

It is a well-known fact that institutional children who receive only perfunctory attention are often retarded physically and emotionally. Moreover, to those with our cultural background, it seems only humane that babies should receive loving attention from those



## 6.6 A Mother Machine.

As described in the text, this sponge-rubber and terry-cloth figure is warmed with an electric bulb. The infant monkey (of course more mature than human infants) clings to it as though it were alive. (From Harlow, H. F., "The Nature of Love," *American Psychologist*, 1958, 13, p. 679.)

charged with their care, and receive such attention whether or not there is an inborn need for it. Nevertheless, the existence of such a need has seriously been questioned, and on several grounds.

Infants who fail to receive affectionate attention are also usually denied a great deal of general stimulation as well as opportunities to explore and interact with aspects of their environment. The babies most affected in one institutional study "experienced not only relative social isolation but virtual stimulus starvation in their toyless, walled-in cubicles."<sup>42</sup> The writers from whom this quotation is taken point to the fact that recent experiments on stimulus deprivation in adults seriously disturbed even these. We are to consider such experiments later in this chapter.

Another criticism of the conclusion that infants need mothering of the kind described comes from those who have studied infant care in other societies than our own. In some societies there is a quite routine caring for infant needs and almost complete absence of

the fondling and other endearments that our babies normally receive, yet without evident bad effects upon bodily development and personality.<sup>43</sup>

One may well ask whether an infant perceives the warmth of its mother's body, the fondling, the rocking, and other aspects of motherly attention. What is more to the point, of course, is the question as to whether it perceives the lack of such — or has a *drive to seek it*. Since the infant cannot communicate, such questions must remain without an answer. Somewhat relevant to the first question, however, are certain experiments with infant monkeys given a "mother machine" to love.<sup>44</sup> These infants gave the usual infant-to-mother reactions even though the mothers of the experiment were synthetic (Figure 6.6). The most acceptable mother substitute was a block of wood surrounded by sponge rubber, sheathed in terry cloth, and with an electric bulb inside to provide warmth. This was more effective than a wire-mesh substitute which, even though it provided

milk and warmth, lacked softness and cuddliness. In times of stress, the baby monkeys ran and clung to their substitute mothers much as monkeys normally do to their real mothers. Does this mean that infant monkeys, and perhaps human infants as well, need soft cuddly contacts? One cannot say. It is one thing to need these and quite another to prefer them to other contacts that are available.

From the foregoing it should be apparent that the question of a need for affection (or related stimulation) cannot be answered on the basis of evidence at present available. One would have to do an experiment in which comparable groups were reared, one with mother love (real or synthetic) and the other without it, but with both groups receiving normal stimulation in other respects. It is doubtful, because of humane considerations, whether any experiment of this nature would be undertaken with human infants.

#### **The need for stimulation**

The above discussion made passing reference to an apparent need for stimulation, saying that deprivation of this, rather than lack of affection as such, might be responsible for the retardation sometimes found in institutionally reared children. Some experimental evidence for such a need comes from a study in which college students lived in an environment as devoid of variable external stimulation as the investigator could make it. The details of the experimental environment are pictured in Figure 6.7 and described in the legend. What was especially lacking was *change* in external stimulation. Since variation in external stimulation is an important basis of general alertness, probably because it activates an alerting mechanism in the brain, the subjects at first slept a great deal of the time. Later, to quote the investigators,

they slept less, became bored, and appeared eager for stimulation. They would sing, whistle, talk to themselves, tap the cuffs together, or explore the cubicle with them. This boredom seemed to be partly due to deterioration of the capacity to think systematically and productively. . . . The subjects also became very restless, displaying constant random movement, and they described the restlessness as

unpleasant. Hence it was difficult to keep the subjects for more than two or three days, despite the fact that the pay (\$20 for a 24-hour day) was more than double what they could normally earn. . . .

The subjects reported that they were unable to concentrate on any topic for long while in the cubicle. Those who tried to review their studies or solve self-initiated intellectual problems found it difficult to do so. As a result they lapsed into day-dreaming, abandoned attempts at organized thinking, and let their thoughts wander. There were also reports of "blank" periods, during which they seemed unable to think of anything at all.<sup>43</sup>

The subjects had hallucinations and dream-like experiences and their performance on items from intelligence tests was inferior to that under control conditions. It is claimed that "both the changes in intelligence-test performance and the hallucinatory activity, induced merely by limiting the variability of sensory input, provide direct evidence of a kind of dependence on the environment that has not been previously recognized."<sup>46</sup>

Investigators at the National Bureau of Mental Health have also been studying the effects of isolation, but with a situation somewhat different from that described. They immersed naked subjects in a tank of slowly flowing water, the temperature of which was kept at a point which made it feel neither hot nor cold. Only the top of the head was above water level. The subjects wore a light-proof helmet which enabled them to breathe through a tube. In addition to being in darkness, in a medium of constant temperature, and in a suspended position, the individuals were also subjected to reduced stimulation in other respects. The sound level was low. A subject could hear only his own breathing, the lapping of the water and some faint water sounds from the piping. Subjects reported the environment to be the most even and monotonous that they had ever experienced. It is reported that, after an hour or two in the tank, "a tension develops which can best be called a 'stimulus-action' hunger; hidden methods of self-stimulation develop; twitching muscles, slow swimming movements (which cause sensations as the water flows by the skin), stroking one finger with another,

etc." Continued subjection to this environment eventually brought such effects as intense concentration on some aspect of the situation (such as the mask), reveries and fantasies, and visual hallucinations.<sup>47</sup>

#### Exploration and manipulation

The exploratory and manipulatory behavior so evident in many organisms is perhaps comparable with what Freud has called reality testing (p. 250). It is undoubtedly related to the "need for stimulation." As we have seen (p. 150), the term "stimulus starvation" has been used in this connection. One investigator speaks of "perceptual curiosity,"<sup>48</sup> another of "motivation to know one's environment."<sup>49</sup> Most of the relevant research has been done on rats, monkeys, and chimpanzees.

In experiments on "perceptual curiosity" in rats, the investigator gave his subjects an opportunity to approach and explore such objects as painted and unpainted cubes.<sup>50</sup> Two of the findings are of special interest. One of these is that an increase in the number and complexity of the stimulus objects increases the amount of exploratory behavior. The other finding is that exploratory behavior declines as the period of exposure to the objects increases. The rats begin to "lose interest" after one minute. It is as though their exploratory drive is being satiated. Other investigators, studying exploratory and manipulatory behavior in different situations, have also observed a satiation effect.

That the exploratory drive can motivate learning is shown by an experiment in which

**6.7 Environmental Restriction.** The subject is lying on a foam rubber bed, wears translucent goggles which prevent seeing of any details, has on gloves which permit free movement of joints but limit tactual perception, and has his head in a foam rubber pillow containing earphones. This pillow is not shown here, it having been removed so that EEG's could be recorded from the device pictured. A constant hum from fans, an air-conditioner, and an amplifier leading to the earphones masks all other sounds. A microphone near the subject's mouth (removed for the picture) is used in reporting experiences. Subjects leave the booth only to eat and go to the toilet. (From the Bell System Science Series Film, *"Gateways to the Mind."*)







**6.8 Visual Exploration.** Each time the monkey made a correct discrimination (pressing panel of proper color rather than that paired with it) the door opened and he could explore with his eyes for 30 seconds. (From Butler, R. A., and H. F. Harlow, "Persistence of Visual Exploration in Monkeys." *Journal of Comparative and Physiological Psychology*, 1954, 47, 259.)

rats learned to choose the white rather than the black arm (others the black rather than the white arm) of a T maze even though their choice brought nothing beyond the opportunity to explore some additional maze pathways.<sup>51</sup> In other experiments mice learned to press the bar of a box, their only reward being the onset of a dim light.<sup>52</sup> Rats learned to step on a small platform which "rewarded" them with such forms of stimulation as its movement and a clicking sound.<sup>53</sup>

Monkeys are notorious for their curiosity, hence it should not surprise us to learn that several studies have been focused upon their exploratory and manipulatory behavior. They have learned to discriminate between pairs of colors with no reward other than an opportunity to look out of a small window (Figure 6.8) and visually explore the environment.<sup>54</sup> When the monkey pushes against a panel containing the "correct" color, the window opens and he may look through it for thirty seconds before a screen drops. The "correct" color is of course sometimes on the right and sometimes on the left, so that a different panel has to be pressed from time to time, and in a chance sequence. When the "incorrect" panel is pressed, the window falls to open.

In another experiment, monkeys learned a similar discrimination with no other reward than the sound of other monkeys heard through a microphone. A correct response

brought this sound and an incorrect one failed to bring it. Monkeys have also solved mechanical puzzles with no reward beyond satisfaction of their manipulatory drive.<sup>55</sup>

Chimpanzees engage in a large amount of exploratory and manipulative behavior. Grooming (picking each other's hair and skin), is illustrative of this. In a situation in which various objects are presented, "The initial approach of the animal to the new object is usually tentative — it gives a quick poke and then quickly withdraws. After the chimp has satisfied itself that the object is not dangerous, it begins to explore and investigate it more thoroughly. The more heterogeneous or variegated the object, the more attention it gets." The results obtained by presenting various objects to the animal indicate that "An object that moves, or one that produces an effect when touched, such as ringing a bell, elicits longer and more detailed manipulations than one which does not move or produce an effect."<sup>56</sup> Interest in a particular object is soon satiated, but the introduction of new objects induces the animal to engage in further exploratory activity.<sup>57</sup>

The exploratory and manipulatory behavior observed in monkeys and chimpanzees is even more evident in human beings and it obviously plays an important role in the learning process, and in what we have already referred to as "reality testing." As one investigator<sup>58</sup> has said,

The human organism expends considerable energy just finding out about the world in which he lives. He explores, he tries things out, or is just curious about things. This kind of behavior is, of course, especially noticeable in children, but it is equally marked in adults who find themselves in a new situation. It would almost seem as though there is a positive motivation to know one's environment.

Persons usually try to find out what they can and cannot do in the environment in which they live. This represents a kind of exploration of themselves which is essentially similar to the exploration of the environment. Taken together we can say that the human being attempts to know what exists in the world around him and to know what his possibilities of action are in that world.

There is no doubt that much of the exploratory and manipulatory behavior of human beings, especially beyond the infant stage, is learned. However, the above experiments with rats, monkeys, and chimpanzees as well as observations of the exploratory-manipulatory behavior of human infants give support to the view that such behavior is rooted in the biological nature of the organism.

Although men and animals have the same basic drives, there is an important biological difference between them in the nature of the behavior that is instrumental in alleviating these drives. Most animals do not need to acquire appropriate habits — the necessary behavior patterns are built into them, in the form of instincts. Human beings, on the other hand, begin their lives as helpless creatures completely dependent upon others. Independence comes to them only as they learn from others how to take care of themselves.

#### PERSONAL-SOCIAL MOTIVES

Our discussion so far has largely dealt with motives which are part of our biological heritage, hence inborn and universal. Their existence is determined by our animal ancestry and not by anything that has happened to us as individuals. Infants, as we have seen, express these motives directly, without reference to social niceties. Adults, on the other hand, are restrained to some degree by a more fully developed ego and superego. It is in these

respects that personal experience plays a role in the regulation of physiological drives.

We now turn to motives which most of us acquire during our lifetimes, largely through individual experience involving other people. It is because of this personal and social origin that acquired motives are often referred to as *personal-social*.

Some motives are acquired by every human being who is normal. They are rooted in the need of all human infants for help from others. These motives are acquired in the family as well as in broader social groups. One of them is the strong desire of human beings to associate with others of their kind.

In addition to motives acquired by all normal human beings there are others found only in particular cultures. In this connection we will have something to say about the achievement motive which is so prevalent and strong in our own culture, yet relatively absent from certain other cultures.

Some acquired motives are more individualistic, more personal, than any already referred to. These are motives which an individual may or may not acquire, depending upon experiences peculiar to himself. Drug addictions fall into this category. So, also, do personal aims, such as to become a nurse, a doctor, or a banker. Interests likewise have an individualistic basis. One person is interested in golf, another in tennis. Attitudes, including prejudices, may be common to a particular culture, or to a given group within a larger cultural setting, but they may also be quite personal in the above sense.

It is evident, from what we have just been saying, that what follows is concerned almost exclusively with *human motivation*, and *adult motivation* at that. But how is the motivation of adult human beings related to the physiological motivation dealt with in the preceding pages? This is not an easy question to answer. Infants, it is true, are physiologically motivated in the ways already described. Their entire behavior, initially, is "drive-impelled" in a physiological sense, and obviously so. As the Freudians would say, they are all id. But how about adult behavior?

Some psychologists, exemplified by Freud, believe that adult behavior is also physiologically motivated, although in more subtle and refined ways than in animals and human infants. Freud, as we know, emphasized sexual

motivation, but others have stressed the influence of hunger, saying that, whatever personal-social motives a man may acquire, he undeniably "lives by bread alone." It can be argued, however, that sex, hunger, and other physiological motives have a significant motivational influence upon adult human behavior only when they are not routinely satisfied. Man lives by bread alone, that is, only when bread is lacking or scarce.<sup>59</sup> The typical adult in our society satisfies his physiological needs as they arise — without having experienced severe deprivation. It has been pointed out that "culture itself is an adaptive tool, one of whose main functions is to make the physiological emergencies come less and less often."<sup>60</sup> But it is man's physiological motivation which, in the first place, leads him to set up safeguards against emergencies referred to. Moreover, when such emergencies do occur, as in war and famine, the most civilized human beings soon revert to animal-like behavior.<sup>61</sup> In some present-day societies, almost every act is hunger-motivated. Take, for example, the Siriono Indians of eastern Bolivia. These naked savages, with an elementary culture including makeshift shelters and almost no agriculture, are dominated by the need for food, of which there is seldom enough. They have intense anxiety about food and, like the semistarved men mentioned earlier (p. 144), their fantasies and dreams are concerned with eating. Quarreling and aggressive acts are usually related to food. The married men often have sexual relations with other women, who are paid for their services with food. The wives get angry about this, not because their husbands are unfaithful, but because they squander food needed by their family. Once the aged and infirm are unable to contribute their share of food, they are abandoned or killed. The prestige of a man in this society is also related to food. "If a man is a good hunter, his status is apt to be high; if he is a poor provider, it is apt to be low."<sup>62</sup>

Suppose that all physiological drives are satisfied as they arise, i.e., that there are no emergencies or other frustrating circumstances. Are we then without motivation related to physiological needs? Obviously not, for anybody can conceive of the possibility that emergencies may at some time arise. Even though he is not now hungry, the individual may be anxious to guard against future hunger. Con-

sequently he may save food, or money with which he can buy it. He may also act to obtain security in other areas relating to physiological need, as when he makes financial preparations for the time when he will marry. The need for money is not a physiological one, but it is nevertheless related to physiological needs when the motivation to obtain it is the desire to secure the satisfaction of these in the future. Some investigators speak of physiological needs as *primary* and those related to securing their satisfaction at some future time as *secondary*. Thus, while hunger is a primary drive, the hoarding of food or of money with which to buy it is a secondary drive. Such secondary drives often depend either upon earlier frustration or on what the individual has learned from his parents and others about the necessity for anticipating future needs.<sup>63</sup>

It is quite evident, then, that personal-social motives may be linked to physiological needs and that those which are indirectly linked are secondary in the above-mentioned sense. We do not mean, however, that all human motivation is, in this sense, physiologically grounded. Some personal-social motives appear to have no present physiological ties, except the neurological basis that is common to all learned activities. This is true in spite of the fact that these motives may have had some connection with physiological need-states in early childhood. Allport looks upon

adult motives as infinitely varied, and as self-sustaining, *contemporary* systems, growing out of antecedent systems, but functionally independent of them. Just as a child gradually repudiates his dependence on his parents, develops a will of his own, becomes self-active and self-determining, and outlives his parents, so it is with motives. Each motive has a definite point of origin which may possibly lie in the organic tensions of infancy. Chronologically speaking, all adult purposes can be traced back to these seed-forms in infancy, but as the individual matures the tie is broken. Whatever bond remains is historical, not functional.<sup>64</sup>

The idea that many adult motives have broken their physiological ties is considered more fully later in the present chapter.

Our statement about personal-social motives has served to indicate their general nature, their origins in individual experience in a social

context, and the connections of at least some of them with physiological motives discussed earlier. Some such relationships are described in the following pages.

We begin our more detailed consideration of personal-social motives by focusing upon those acquired by *all* normal human beings.

### COMMON SOCIAL MOTIVES

The social motives found in most, if not all, normal human beings are well exemplified by desire to associate with others. All organisms that are long dependent upon others for survival become greatly disturbed when isolated.

The motive to keep in contact with others is called *gregariousness*. It is so nearly universal in human beings that some have thought it inborn. However, certain influences associated with infantile helplessness could easily cause every individual to acquire it.

Through the learning process, stimuli and activities associated with the satisfaction of needs acquire increasing potency to arouse motivated behavior. To an infant, the mother is at first merely a means of satisfying basic needs. But long before she has outlived her usefulness in this respect, the infant's mother becomes a cherished object of its surroundings. Likewise any others who are closely associated with satisfying its needs develop an attractiveness in their own right. That is, apart from the role that they play in the satisfaction of needs. Most of our physiological needs are normally satisfied in association with other human beings. As one grows older, his group contacts broaden. For example, he plays with others and almost all of his recreational activities occur in a social setting.

Thus there is no necessity for supposing that our strong desire for human associations is inborn. It seems much more reasonable to suppose that gregariousness is learned. It is learned by all, because all go through a period of helplessness and dependence upon others. Indeed, a term has been coined to represent these "common modes of learned response that are the products of original nature and commonly shared environment."<sup>65</sup> The term is *coenotrope*. It is derived from two Greek words which mean "common habit."

There would be no point in attempting to list all of the coenotropes.<sup>66</sup> In addition to gregariousness, two good candidates for such a list would be: (1) the tendency to imitate, which most human beings learn because they find it to their advantage to do so, and (2) the tendency to appeal to stronger individuals than ourselves or to superhuman agencies when our own resources fail. These motives also have their beginnings in human helplessness and in the necessity in early years of being cared for by others.

Common social motives are of course fostered by literature as well as by face-to-face contacts of many kinds.

### MOTIVES VARYING WITH THE CULTURE

Many motives, rather than being universal, are limited to our more restricted cultural group. In our society, for example, most of us develop a very strong urge to assert ourselves, to achieve, or to get recognition in some shape or form. This has been called the *achievement, self-assertive or mastery* motive. It is expressed in leadership, in self-display, and in a wide range of competitive activities. Moreover, this motive may derive, in part, from the sort of independence-training to which children in our culture are subjected.<sup>67</sup>

#### Variations in achievement motivation

What is of especial interest to us here is the fact that the motive to achieve, or to assert oneself, is absent in certain societies. Among the Arapesh of New Guinea, self-assertion is so rare as to be regarded as abnormal.<sup>68</sup>

Self-assertiveness is rare among the Arapesh and certain other groups because it is frowned upon by the adults and discouraged. In our own society self-assertiveness is a strong motive because from very early childhood it is encouraged. We want our children to excel and we set an example of self-assertiveness which they cannot fail to observe, and find advantages in copying.

Our restless urge to achieve is interestingly contrasted with the passivity of certain other cultures in the following report of a conversation between an Indian and a missionary bent

on improving the Indian's social and financial status.<sup>69</sup>

*Missionary:* Brother, why don't you go to the big city and get a job in a factory?

*Indian:* Suppose I get a job, what then?

*M:* If you get a job, you will get money and you can have many things.

*I:* What then?

*M:* Well, if you do your work well, you will be promoted, become a foreman, and have more money.

*I:* What then?

*M:* Oh, then you may become the superintendent of the factory if you work hard enough.

*I:* What then?

*M:* If you study all about the business and work harder, you may become the manager of the whole business.

*I:* Suppose I become the manager, how would that benefit me?

*M:* If you are an able manager, you can start a business of your own and have more money than ever.

*I:* What then?

*M:* Oh, eventually, you will have so much money that you won't need to work at all.

*I:* That, paleface, is what I'm doing now. Why go to so much trouble to gain what I already have? The white man has the restless sea within his bosom, but the Indian dreams with the stars and looks on.

### **Aggressiveness**

Another motive that is prevalent in many societies, including our own, but which is extremely rare in some, is *aggressiveness*. The motive is most typically aroused by frustration, by hindrance with the satisfaction of needs, physiological or acquired, but it is suppressed or fostered, depending upon the group norms. The Arapesh of New Guinea are a peaceful people who discourage displays of anger and aggression. The Mundugumor, on the other hand, foster aggressiveness, even from the time of infancy. Take the feeding situation, for example. It is one where the child must keep sucking or forego his meal. In this situation,

Children . . . develop a very definite purposive fighting attitude, holding on firmly to the nipple and sucking milk as rapidly and vigorously

as possible. They frequently choke from swallowing too fast; the choking angers the mother and infuriates the child, thus further turning the suckling situation into one characterized by anger and struggle rather than by affection and reassurance.<sup>70</sup>

As he becomes older, the Mundugumor male is trained in a manner calculated to fit him for survival in battle. In this training, modes of fighting have a large place. We see the same sort of parallel between the Zuñi and Comanche Indians. The Zuñi, a pastoral people, expressed their peacefulness even in their long flowing robes. The Comanches, on the other hand, were noted for their pugnacity. Comanche males were taught to be fighters and they dressed and equipped themselves in a manner suggesting aggressiveness.

Aggressiveness was once thought to be universal, inborn, and ineradicable. Its alleged innateness was often quoted in support of those who believed war to be inevitable. Today we realize that man is by nature neither warlike nor peaceful. It is true that he has certain physiological needs which demand satisfaction. But if he can satisfy these without hindrance, and he has not been conditioned toward pugnacity by his group, his behavior is characterized by peacefulness. On the other hand, actual or anticipated frustration of basic needs arouses anger and, quite frequently, aggression directed toward the persons or situations responsible. One must not overlook the additional fact that each of us is born into a situation where certain culture patterns, including traditional antipathies, already exist. These may mold us into aggressive or peaceful individuals, regardless of whether satisfaction of our needs is thwarted or threatened with frustration.

### **PERSONAL MOTIVES**

Many motives are much more personal than those already mentioned. They are, so to speak, variations on the universal or cultural theme. Thus, while all normal men are gregarious, their gregariousness is expressed in individual ways. Some are satisfied to limit their contacts to family and neighborhood while others crave attendance at clubs or participation in larger social groups. Some are pas-

sive in group situations and others active. Some lead and others follow. By the same token, the self-assertive members of our civilization assert themselves in a variety of ways, some in bodily contacts and some through the spoken or written word. Most men seek recognition in limited ways and others are satisfied only with national or world-wide recognition.

Specific goals also differ. Whether their basic aim is to achieve recognition or merely to achieve security, some men want to be doctors, others lawyers or engineers. Still more individualistic are such motives as the desire to collect stamps, coins or antiques. More individualistic still is the desire to marry a particular person or fill a particular position.

Although such personal motives may at times be traced back to physiological drives and cultural influences, the roots are usually devious and widespread. It often happens that two or more competent psychologists start from the same point and arrive at quite different conclusions concerning the motivation for particular cravings, desires, or ambitions.

The problem of what motivates people to act as they do is also complicated by the fact that motives are strengthened or weakened by outcomes. Quite often we get what we want only to find that it is no longer as appealing as it once was. Sometimes we work toward a limited goal and, after reaching it, acquire many wants that were not present before and which require additional efforts. Sometimes, too, motives undergo radical changes—we are converted to new ideals and change our goals accordingly. The following quotation<sup>71</sup> provides a good illustration of some of these complexities of human motivation:

A man of great wealth finds that his ruthless business practices have made him an object of hatred and scorn in his country. He grows old, gets religion, and begins to worry about his soul. He needs social approval, and he needs it desperately. On the advice of his friends he hires an eminent public relations expert, who advises our millionaire to become a great philanthropist—to give large sums of money to churches, universities, research foundations, hospitals, libraries, etc. This is done, and gradually the name that was anathema to the public becomes highly respected. But

the millionaire continues to give money to the support and expansion of these many institutions. Why?

The answer . . . might be that this behavior is still an attempt to satisfy the "basic" need that was assumed to be initially responsible for his philanthropic gestures or else that through habitual money giving, this behavior has become a "drive." [But] this behavior may be due to *new* needs or demands not necessarily related to the earlier needs or demands. Our millionaire, in giving money to public institutions, has met theologians, scientists, philosophers, writers, doctors—people whom he had not known on intimate terms before. He may have become interested in new concepts; he has been exposed to new ideas, talked with men of strange enthusiasms. All this could very well have altered his cognitive structure, his range of appreciations, and even his personality structure in such ways as to invoke new needs and demands.\*

#### LIFE GOALS

When we consider motives like the desire to become a doctor, a sailor, a lawyer, a banker, a merchant, or a teacher, the roots spread in so many directions that it is all but impossible to follow them. Every individual's life goal, even when it is shared with others, has somewhat different origins. One may wish to be a doctor because he sees it as a good way to make a living; because his childhood curiosity about bodily functions was never satisfied; because, in his play activities as a boy, he obtained satisfaction out of doctoring other children with the aid of the toy doctor's kit which somebody gave him; because religious teachings have imbued him with the idea of serving his fellow men and he sees the doctor as a servant of mankind; because his pals are going to be doctors; or perhaps for any one of a hundred other reasons. Sometimes a combination of influences like those mentioned underlies one's selection of a life goal.

It is often apparent, when we investigate a person's life history, that his many different

\* From *Theories and Problems of Social Psychology* by Krech and Crutchfield. Copyright, 1948. Courtesy of McGraw-Hill Book Co.

activities have a common theme — are similarly motivated. Sometimes the motive is a desire for recognition, and sometimes it is a desire merely to become self-dependent. The so-called "will to power" is often suggested as the connecting thread.

While personal histories differ in details, most of them suggest that a predominant motive is established in childhood, largely through the influence of social contacts. As the individual gets older, one activity after another may be taken up while others, which no longer contribute to satisfaction of the predominant motive, or which contribute less than the new activity, are dropped.

It quite frequently happens that frustration early in childhood creates a strong desire for recognition, for mastery or for self-assertion. The aggression of men like Hitler has been attributed to early frustration. Adler has claimed that the frustrations of childhood create in most of us a "will to power." At least it is clear that, if an individual has some predominant motive, like a desire for recognition, it is a "thread" which runs through many different activities.

### LEVELS OF ASPIRATION

In choosing life goals and in undertaking everyday activities, individuals differ widely in their level of aspiration — that is to say, in their expectations of accomplishment or in the demands which they make upon themselves. One individual, let us say, aspires to become a cab driver; another a doctor. Some expect to attain a salary of twenty thousand dollars per year while others expect to attain only five thousand dollars. Likewise, if you ask individuals how accurately or how quickly they can perform a particular task, some will set for themselves a high level of accomplishment and others a much lower level.

General observation shows that one's level of aspiration is usually modified from time to time in terms of his success or failure in attaining his goals. Students who aspire to be physicians, but find the premedical requirements beyond them, eventually lower their level of aspiration. Some then aspire to be salesmen for pharmaceutical manufacturers. One student, known to the writer, aspired successively to becoming a physician, a den-

tist, and a mortician. The latter occupations are, of course, worth while and necessary, but for one who first aspires to become a physician, they represent a lowered level of aspiration. One value of aptitude testing, considered in Chapter 5, is that it facilitates the setting of a level of aspiration which is in keeping with possibilities of attainment. Some of the unhappiest people in the world are college students who, because of insufficient intelligence, consistently fail to meet the standards required, or have exceptional difficulty in meeting these standards. The same individuals would be far happier if their parents had ascertained earlier in their lives the things that they might be expected to accomplish successfully or without abnormal strain. Some of them would then have been encouraged to develop goals along these rather than along educational lines. Many an unhappy student might, under these circumstances, have been a happy mechanic or clerk instead.

Some individuals enter academic work with the goal of getting a B.A. and then entering a nonacademic field. Finding themselves successful beyond their original anticipation, however, they often go ahead to the Ph.D. degree and become teachers themselves. Thus, while failure tends to lower the level of aspiration, success tends to raise it.

Laboratory investigations on levels of aspiration deal with this concept in a more limited sense than that already described. Subjects are asked to indicate what level of performance they will undertake to achieve on some such task as solving puzzles, placing pegs in holes, tracing through mazes, or shooting a steel ball along a groove as illustrated and described in Figure 6.9. They then perform the task one or more times. After this, they are told their actual performance and asked to state their level of aspiration for a further performance of the task. This is continued for a number of trials. Sometimes an individual is not told his actual accomplishment, but is given a fictitious score which he believes to be his own. Sometimes he is told that others have accomplished a particular score on the task. This is to test the significance of social influences. Finally, the differences between levels of aspiration and levels of actual achievement are determined. The experimenter then calculates how success or failure in meeting the



**6.9 A Level of Aspiration Board** The subject tells the investigator what score he expects to make as he projects the ball up the groove. By repeating the procedures for a series of trials the experimenter is able to study how success or failure influences the verbalized expectancies (or aspirations) of the subject concerning his future performances. (From Ratter, J. B., *Social Learning and Clinical Psychology*. Prentice-Hall, 1954, p. 129.)

designated level influences the level of aspiration.

The results of these investigations are not easily summarized. In general, the level of aspiration stays pretty close to actual performance, but there is a tendency for it to remain above rather than below actual performance. There is a tendency, too, for the individual to raise his goal after success more than to lower it after failure. The influence of social factors is suggested by the observation that individuals tend to raise their level of aspiration when told that average performance, especially of a group regarded as inferior, is above their own.<sup>72</sup>

Such findings as these are often closely duplicated in everyday life. This has been revealed by a study in which college students reported on incidents in their own lives. Each student wrote a description of three well-remembered incidents in his life — one involving frustration which prevented him from reaching a goal, one involving achievement of the goal following frustration, and one involving attainment of a goal without appreciable frustration. In each instance involving frustration,

Table 6.1 Summary of Frequency of Reported Shifts in Level of Aspiration Produced by Each of Three Types of Incidents \*

Type of incident	Frequency of each shift in level of aspiration		
	Lowering	None	Rise
Complete frustration	66	36	33
Frustration followed by goal-attainment	15	15	95
Simple goal-attainment	3	17	121

this was to have been brought about by another person and the goal achieved was to have involved other persons. After the frustrating incidents had been reported, the students were asked to tell the effect of the incident on their level of aspiration. The chief results are summarized in Table 6.1. It is clearly evident that complete frustration led about twice as many students to lower as to raise their level of aspiration.<sup>73</sup> Success in goal attainment led a very large proportion to raise their level of aspiration.

Levels of aspiration are influenced by the person's attitudes toward himself and by his estimate of his group status. He gains or loses self-esteem as he succeeds or fails to reach his goals and, if the group is directly involved, so as to be a "witness" to his achievements, he feels that he has gained or lost status, or "face." Such self-attitudes have been called *ego-involvements*. A concept of self, with related ego-involvements, probably precedes the setting of levels of aspiration. "The level of aspiration does not seem to appear clearly until the child has formed some conception of his 'self' — until he has developed a sense of 'pride' which he feels must be maintained." <sup>74</sup>

## FUNCTIONAL AUTONOMY

In an earlier discussion (p. 155) we referred to the fact that some motives developed in

\* From Child, I. L., and J. W. M. Whiting, "Determinants of Level of Aspiration: Evidence from Everyday Life," *J. Abnormal & Soc. Psychol.*, 1949, 44, 308.



relation to physiological needs appear to function without such a linkage in adult life. To quote Allport again, the bond that remains in adult life is "historical, not functional." This concept has also been applied by Allport and others to the persistence of habits even though the motives which originally led to their acquisition are no longer operative. It appears, at times, that habits have themselves acquired the status of drives.<sup>75</sup> Some possible examples of functional autonomy are persistence of sexual behavior after the menopause, when estrogens are no longer present; persistence of a vocational activity after the individual has made his fortune and achieved distinction; and "living to eat" instead of eating to live. Still another possible example would be the persistent giving of the philanthropist whose donations were at first initiated by the desire to achieve desirable group status.

In most instances of apparent functional autonomy there is, as in the case of the hypothetical philanthropist, a possibility that new motives have supplanted the original ones. Even the man who has made a fortune and achieved the utmost distinction may feel that he must keep working so as not to be regarded as a "has been," a "quitter," or one of the "idle rich."

In such instances as we have just cited, habits are autonomous from the standpoint of the original motives, but they are not altogether without extraneous motivation.

Perhaps a good example of functional autonomy is to be found in the case of some gifted people who are alleged to "demand the exercise of their talents, even when no other reward lies ahead."<sup>76</sup>

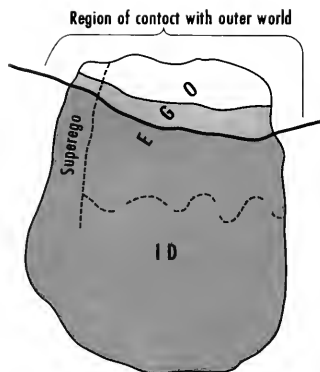
### FORCE OF HABIT

In cases of functional autonomy, as we have seen, the habit is freed from at least its original motivation. Force of habit, on the other hand, is persistence of a particular way of satisfying a given motive. For example, if we satisfy the hunger drive by eating foods prepared in a certain way, there is often resistance to eating foods prepared in some other way. Likewise, if an older person's need for rest and recreation is customarily satisfied by sitting quietly at home, perhaps reading, he may resist the sug-

gestion that he go to a movie or to a bridge party. In other words, habit forces us "into a rut." This phenomenon is often referred to as "force of habit," as though habits once formed act somewhat as drives, impelling us to continue the accustomed ways instead of taking up new ways of satisfying our motives. The social significance of this tendency for habits once formed to persist is indicated in the following quotation from William James, one of the greatest early American psychologists.<sup>77</sup>

Habit is the enormous fly-wheel of society, its most precious conservative agent. It alone keeps us all within the bounds of ordinance, and saves the children of fortune from the envious uprisings of the poor. It alone prevents the hardest and most repulsive walks of life from being deserted by those brought up to tread therein. It keeps the fisherman and the deck hand at sea through the winter; it holds the miner in his darkness, and nails the countryman to his log cabin and his lonely farm through all the months of snow; it protects us from invasion by the natives of the desert and the frozen zone. It dooms us to fight out the battle of life upon the lines of our nurture or our early choice, and to make the best of a pursuit that disagrees, because there is no other for which we are fitted, and it is too late to begin again. It keeps different social strata from mixing. Already at the age of twenty-five, you see the professional mannerism settling down on the young commercial traveler, on the young doctor, on the young minister, on the young counselor-at-law. You see the little lines of cleavage running through the character, the tricks of thought, the prejudices, the ways of the "shop," in a word, from which the man can by and by no more escape than his coat-sleeve can suddenly fall into a new set of folds.

James may have exaggerated somewhat the permanency of habitual modes of behavior, for people often do change their prejudices and, during war or other emergencies, their ways of living. However, there is strong resistance to change. Anyone who wishes to change the behavior of an adult must take into consideration his tendency to persist in his well-formed habits.



**6.10** Schema Representing Freud's Concept of the Unconscious. This shows Freud's concept of the relation of the id, ego, and superego and illustrates that he conceived of the id as completely unconscious and the ego and superego as partially so. The blue portion (unconscious) represents everything in our mental make-up of which we are never aware—what can never be verbalized. Anything represented by the gray area (preconscious) may come into awareness—may be recalled. The white region represents everything of which we are aware at any given time. The student should not, however, take this as a representation of any physical structure, like the brain. Rather, it deals with functional relationships, and even then only in terms of analogy. The basic model is an iceberg with most of its mass always below the surface. (After Healy, Bronner, Bowers.)

## UNCONSCIOUS MOTIVATION

The fact that individuals are not always aware of their motives, or of why they do what they do, is well recognized. Freud (see Figure 6.10) regarded the id as unconscious and the ego and superego as partially so.

### Phobias

Some of the best examples of unconscious motivation come from the study of *phobias*,

which are abnormal fears of particular objects or situations.

A Midwestern English professor had, as long as he could remember, an intense fear of going more than a few blocks from his home. This fear was so strong that he had always lived in the same house and within a narrowly circumscribed area. He did not know the basis for his fear. During the course of psychoanalysis he recalled that, as a child of three, he wandered from his mother over to the railroad tracks. A train coming into the station rushed by and he was scalded by the steam. Although he failed to remember the incident until adulthood, the fear aroused by it had motivated him to stay near his home. The professor's book, entitled *The Locomotive God*, gives an account of the effect of this incident on his subsequent conduct.<sup>78</sup>

A girl had a fear of running water which was so strong that it required the combined efforts of several members of her household to bathe her. Even when she went to school, the sound of a drinking fountain frightened her. While riding on the train, she lowered the curtain so that she would not see streams over which the train passed. The girl, even at the age of twenty, did not know why she acted in this way. However, when she was twenty an aunt whom she had not seen for thirteen years came to visit the girl. The aunt's first words on again meeting her were, "I have never told." This led the girl to recall an accident which she experienced at the age of seven years while walking in the woods with her aunt. The child had promised her mother, when she left, that she would be strictly obedient. However, she ran off from the aunt and, when found, was wedged among the rocks of a small stream into which she had fallen. A small waterfall was pouring down on her head and she was screaming with terror. Her aunt dried the child's clothes and promised that she would never tell the mother of her disobedience.<sup>79</sup>

### Hypnosis

Post-hypnotic suggestion provides another good example of unconscious motivation. The subject is hypnotized and told that when he wakes up he will remember nothing of what happened. He is also told that, upon waking,

he will perform a certain act. After he is awake, the subject feels a compulsion to carry out the act suggested, but he does not know why. For example, a girl (S) in a psychology class was hypnotized. Tests demonstrated that she was in a deep trance. Then the hypnotist (H) said, "After I have counted to ten, you will wake up. You will return to your seat and be wide awake. When I scratch my head during the course of the lecture, you will get up from your seat and go to my office, where you will find a laboratory coat hanging behind the door. You will bring the coat here, into the classroom, and put it on me. I may not want to put it on, but you must get it on me." H then said, "One-two-three — you are waking up — four-five — you are becoming wider awake — six-seven-eight — you are getting wide awake — nine — you are almost awake — ten — you are awake." S opened her eyes, looked a little embarrassed, and returned to her seat. When asked, she said that she remembered nothing that had happened from the time she felt her eyes getting tired until she woke up. H continued with the lecture and, several minutes later, scratched his head. The subject sat still, but looked a little uneasy. However, the lecture was continued. A minute or so later, S, with a great deal of hesitation, left the room. Shortly she returned with the laboratory coat. She said to H, "You had better put this on." H said that he didn't need it. S insisted, saying, "It is rather cold in here and this will keep you warm." H insisted that he did not need it; that the room wasn't cold enough to put it on. S now became very insistent. She tried to get H's arm in the sleeve, insisting, now, that chalk might get on his clothes if he didn't put on his coat. After a few minutes, S began to plead with H to put on the coat. This he finally did. S then seemed greatly relieved and returned to her seat.

When asked why she had done what she did, S said that she didn't know. She said that the idea occurred to her when the instructor scratched his head, but, realizing how silly it was, she decided not to do it. Finally, she could not resist. S said she knew she would feel better if the impulse were followed.

Under the influence of hypnosis, patients have been told that cigarettes will nauseate them, that they will dislike the taste of alcohol, or that they will concentrate better on their

studies. The suggested effects are experienced, for varying lengths of time, but the patient usually does not know why he is nauseated by the cigarette, dislikes alcohol, or is so much better able to concentrate on his studies.<sup>80</sup>

### Unconscious attitudes

Seldom are we aware of the basis for our particular interests, attitudes, and aspirations. The gentlemen who prefer blondes may have had pleasant experiences in childhood while playing with blondes or while being handled by blondes. Favorite heroines may have been pictured as blondes. There are many possible bases of such preferences.

Dislikes may be unconsciously motivated. Thomas Brown \* put it this way,

I do not love thee, Doctor Fell,  
The reason why I cannot tell;  
But this alone I know full well,  
I do not love thee, Doctor Fell.

A psychologist<sup>81</sup> reports on the unconscious motivation underlying his dislike for a person:

I met a man named Snyder, and for some peculiar reason felt constantly suspicious of him. . . . I could find no definite reason for disliking him, until one day it occurred to me that a number of years previously I had read a story in which a person named Snyder was a thoroughgoing villain. Having thought of this explanation, all my ill feeling departed and the real Mr. Snyder became a very good friend of mine.

Even slips of the tongue, forgetting of appointments, and other simple acts of everyday life are traced to motives of which the individual may not be aware at the moment. Thus, the bored hostess, after an insufferable evening, said, not what she intended (but what she meant): "Well, goodbye, I'm so sorry

\* He apparently got the idea from Martial, a Latin writer of the first century A.D. who said, "I do not love thee, Sabidius, nor can I say why; this only I can say, I do not love thee." (From Bartlett's *Familiar Quotations*.)

you came." Likewise, the deb at a dance, much interested in a certain young gentleman, intended to ask him when he was going to dance with her, but instead asked, "When are you going to marry me?" What led a radio announcer in introducing a singer to refer to her as a "charming young sinner" and another to refer to a certain person as "a bottle-scarred veteran"? There is no good reason for supposing that all such lapses are unconsciously motivated—some may be purely accidental—but there is no doubt that many have such motivation.<sup>82</sup>

### INCENTIVES AND EFFORT

Incentives are the objects or goals toward which motivated behavior is directed. In a sense we may regard them as inducements to act. In experiments on animal learning, we offer the animal food, sex, water, a means of escape from punishment, a means of returning to familiar surroundings, or perhaps an opportunity to return to the young. Food, sex, water, and opportunities to return to a more desirable situation are inducements to effort—in other words, incentives. It is perhaps obvious that these are incentives only if the animal is suitably motivated. For instance, to an animal whose stomach is full, food is often no incentive at all.

Incentives such as we have mentioned are also effective, under suitable physiological and external circumstances, in arousing human action. In the home, classroom, and industry, however, the incentives used are indirectly, if at all, related to basic physiological drives.

Money may satisfy the hunger drive by making possible the purchase of food. Its incentive value then rests upon satisfaction of hunger. On the other hand, people who are not hungry, and who do not need additional money in order to satisfy hunger, are still induced by money to put forth much effort in the performance of various tasks. In some instances they are motivated, not by hunger, but by a knowledge of the fact that money will buy clothes which enhance their attractiveness to the opposite sex. In other instances money has incentive value because it provides a means of gaining prestige, and thus satisfying social motives such as self-assertion and the desire for recognition. This by no

means exhausts the motives, physiological, social, or personal, which money may tap.

The fact that piece work and bonuses induce workers to put forth increased effort is well known. Introducing such wage incentives often increases the output even of highly skilled workers.<sup>83</sup> However, interests and attitudes aroused in workers toward their jobs, toward the management, and toward each other are often as significant as material incentives.<sup>84</sup>

An experiment carried out at the Hawthorne Works of the Western Electric Company over a number of years seemed to show that increased pay, shorter hours of work, improved lighting and ventilation, rest pauses, and refreshment periods were inducing girls to increase their output of electric relays. Each time a new incentive was introduced, production went up. However, when the girls were returned to the original working conditions, their output not only failed to drop to former levels, but it continued to improve. The conclusion finally forced upon the investigators was that the girls were motivated not so much by external incentives as by increased morale related to the fact that they were selected for the experiment and that the company was apparently interested in them as individuals rather than as mere cogs in the industrial machine. Moreover, common interests and attitudes relating to their experiment gave the girls an *esprit de corps* which went beyond that usually found in industrial situations.

Capitalizing on the findings of this experiment, the company introduced an interview system whereby each employee could air his criticisms to, and talk about personal problems with, a person who would listen and report to the management, but without divulging names. Better morale was thereby introduced because the workers felt that the management was interested in them as persons.<sup>85</sup>

### INTERESTS AND ATTITUDES

Interests and attitudes are learned predispositions to react in certain ways to aspects of our environment. A hungry animal is more receptive to food than to other aspects of its environment. Similarly, the student interested

in science may be more receptive to physics than he is to English literature; the person who has a negative attitude toward the Democratic Party is thereby more likely to see the platform of this party in an unfavorable light and the platform of the Republican Party in a favorable light. Interests and attitudes thus provide further illustration of the fact that, instead of responding indiscriminately to every stimulus which impinges upon our nervous system, we react selectively—we exhibit personal autonomy or self-regulation.

### Interests

Both interests and attitudes predispose the organism to react in certain ways, both are learned, and both may be tinged with feeling and emotion. Interests, however, are always positively directed. We are interested in a person, an occupation, a hobby, or a book. The individual usually likes the things in which he is interested. We would not say that he was interested in something for which he had an aversion. Moreover, interests are usually active rather than passive. We seek to do the things which interest us.

An interest is accompanied by pleasant feeling and by a dynamic tendency to seek the object or do something with it . . . interest in the movies means that one enjoys attending them and does so. . . . A measurement of one's interests is also a measurement of what one will do, other things being equal. . . . As one does not long continue to like what one cannot do, it is also to be expected that a measurement of one's interests is approximately a measurement of what one can do.<sup>86</sup>

The reader may recall that two widely used interest inventories were described (pp. 120–121) in an earlier chapter concerned with interests in relation to aptitudes.

Interests may be acquired in early childhood or later. Some change a great deal with age and some are maintained throughout life. They are usually developed in relation to, and remain allied to, more basic motives. In satisfying his need for activity, or perhaps his curiosity, or both, a child may, for example, play with toy trains, go to the railroad station to watch the trains coming and going, read about trains, and so on. This interest in trains,

perhaps begun with a train trip, receipt of a toy train, or the like, may be retained through the years until, in adulthood, the individual finds his career in some aspect of railroading. On the other hand, through fortuitous circumstances, such as receiving a gift of something more enticing than toy trains, moving to a new locality, and being preoccupied with school, the boy's interest in trains may become secondary, or even disappear. He may turn his attention elsewhere.

### Attitudes

Whereas interests are always positive in direction, attitudes may be positively or negatively directed. Our attitude toward a political party, a person, a race, a nation, a book, or a movie may, if we have any attitude at all, be favorable or unfavorable. Interests are directed toward specific objects and persons, while attitudes tend to be broader in scope, being directed among other things, toward races, nations, institutions, groups, and general ideas and issues. Moreover, attitudes are more passive than interests. We are more likely to have attitudes and do nothing about them than we are to have interests and do nothing about them. Nevertheless, when we are called upon to make decisions, to act, and to express opinions, our attitudes determine the outcome just as strongly as do our interests. As a matter of fact, attitudes are usually defined as *determining tendencies*.

### Prejudices

Attitudes toward races, nations, ideas, institutions, and the like, are sometimes referred to as *prejudices*, because such attitudes lead us to prejudge an issue. Thus, if we are prejudiced against a person who is accused of a crime, we are likely to regard him as guilty, regardless of the evidence; or, if we examine the evidence, we do so with partiality, giving more weight to the damaging than to the exonerating evidence. We can also be prejudiced in favor of some individual or thing. Thus, our country can do no wrong, our children are the most beautiful and best-behaved, and our school is beyond criticism, at least from an outsider. When the word "prejudice" is used without qualification, however, it cus-

tomarily refers to a negative attitude.

Like many attitudes, prejudices begin in childhood. They are usually taken over from parents and others through verbal contacts rather than from personal experience. Some may be purely verbal, at least initially. A case in point is the small boy whose mother told the psychologist that he hated colored people. When interviewed, the child made it evident that his mother had warned him about colored people. He said: "I don't like colored people. I just like people who are black and white." The thought processes of highly prejudiced children and adults have been compared with the thought processes of the relatively unprejudiced. Among other things, it has been found that racial, religious, and other forms of prejudice are related to mental "rigidity" rather than "flexibility." By rigidity is meant a tendency to hold to one's views regardless of the evidence.<sup>87</sup> This is exemplified by a person who told the writer, "I don't care what the research shows, I have a feeling in the pit of my stomach that this race is innately inferior to our own."

### Investigating attitudes

Suppose that the reader is asked to state his attitude toward some moot issue, such as whether fraternities are a good thing for the campus, whether the honor system should be adopted, or whether the consumption of alcohol by students should be made illegal. If such a statement is to be given openly, in the presence of his peers, any person may express his sincere opinion or he may suppress it. If he expresses any opinion at all it may be what he thinks others expect of him. In this event, there may be a discrepancy between what he really believes and what he says.

One way to uncover personal or private attitudes is to ask for an anonymous expression of opinion. That is, we may ask individuals to indicate their attitudes on slips of paper to which no names are attached. Quite frequently the investigator presents various statements about an issue and the subject indicates, with respect to each, whether he agrees, disagrees, or is uncertain. There may be many statements, each of which expresses an affirmative, a negative, or a neutral attitude toward the issue.

In an attitude scale dealing with war, for example, there are twenty-two statements of which the following are representative:

Compulsory military training in all countries should be reduced but not eliminated.

The benefits of war outweigh its attendant evils.

He who refuses to fight is a true hero.

An organization of all nations is imperative to establish peace.

War in the modern world is as needless as it is suicidal.

The individual who fills out this attitude blank, containing twenty-two statements like the above, is asked to put a check mark against each statement with which he agrees, a cross against each statement with which he disagrees, and a question mark against those statements about which he is unable to decide. After the individual has filled out the blank, the statements checked are noted and their scale values recorded.

Scale values are determined, while the scale is being developed, by requiring a large group of judges to assign each statement a value from 1 (extremely militaristic) to 11 (extremely pacifistic). Judges are not called upon to say whether or not they agree with the statement, but merely to say, for example, whether the statement, "War in the modern world is as needless as it is suicidal," represents an attitude in favor of or against war, and to assign it a value between the two extreme values of 1 and 11. Each judge assigns a value to each statement selected tentatively for inclusion in the scale. Then, by a statistical method which we need not consider here, the median value of each statement is determined. Those statements concerning the value of which the judges are in close agreement are selected for the final scale.

The scale values of the statements listed above in order from top to bottom are 5.4, 2.7, 10.6, 7.0, and 9.5. One can see that the first statement, according to the judges, represents a neutral attitude (halfway between 1 and 11). The statement most in favor of war is the second, with a value of 2.7. On the other hand, the third statement, with a value of 10.6, represents a pacifistic attitude.<sup>88</sup>

An individual's score is the median value

of the endorsed statements. The other statements are ignored. Thus, a person who endorsed such diverse statements as those used here for illustrative purposes would have a median score of 7.0, which indicates "strong pacifism."<sup>9</sup>

Such scales have many practical and scientific uses. Much research has been reported on changes in attitudes resulting from such influences as a college education, change of residence from one part of the country to another (say North to South), various types of propaganda (emotional versus rational appeals), persuasion through the radio or the printed page, seeing moving pictures, or listening to female rather than male speakers. Such changes in attitude are often measured by using comparable forms of an attitude scale, one form given before and the other after the experimental variable has been introduced.<sup>89</sup>

A somewhat different study sampled the attitudes of teenagers on several issues. Every subject indicated anonymously whether he agreed, disagreed, or was uncertain about specific questions or statements on each issue involved. Some of the results obtained in one nation-wide sample of 3000 teenagers are represented graphically in Figure 6.11. The overall results show that teenagers in the United States today are predominantly conformist in their attitudes on controversial issues. Going with this is "extreme sensitivity to the opinions of others." In recording their problems and desires, moreover, the same teenagers showed great concern for status in their own group—54 per cent wanted people to like them more, 50 per cent wanted to make new friends, 42 per cent wished that they were more popular. Other things like wanting to get rid of pimples (33 per cent) and wanting to gain or lose weight (52 per cent) are also relevant to the desire to be popular.<sup>90</sup>

An overall attitude of conformity and a related desire for popularity are not peculiar to adolescents. They develop at early age levels, as a result of parental and other social pressures, and they are then carried on into

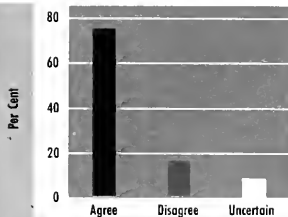
adulthood. A study which used projective procedures to investigate attitudes on certain controversial issues, first in college students and then in children, yielded results of great interest in this connection.<sup>91</sup>

### A projective study of attitudes

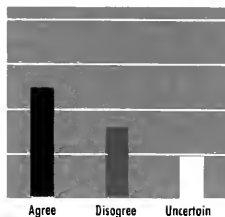
One type of personality test requires subjects to complete partial statements such as "My chief aim in life is. . . ." In the investigation to be described here there were two types of such statements. One said, for example, "If a Negro moved onto my street I would. . . ." This is of course a direct statement which puts the individual who completes it on record as having a particular attitude. In the study under consideration, statements of this type were regarded as *direct* rather than *projective*. A parallel statement, but on a projective basis, would be: "If a Negro moved onto his street, Bill would. . . ." The latter statement did not so evidently implicate the person who completed it. His own involvement was even less evident when he filled out such a series of statements as quickly as possible in the belief that he was taking a speed test of Verbal Intelligence. The assumption here was this: Since the subject does not have to state what *he* would do, and since his attention is diverted from the true purpose of the test through the instruction to complete *these tests of Verbal Intelligence as quickly as possible*, he will seek the readiest possible completion and this will represent his personal attitude on the issue involved. The real purpose of the test was further disguised by mixing in many items on noncontroversial things, such as, "When he has an opportunity to do so, John likes to. . . ." or "John often feels that he should. . . ."

A group comprising forty-eight freshmen and sophomores in a New England woman's college filled out as quickly as possible a "Verbal Intelligence Test" containing fifty-nine projective items such as we have described. These dealt with attitudes toward mother, father, religion, racial groups, and noncontroversial and impersonal issues. Ten Negro items were included and subjected to special study because, "In a New England liberal arts college community there are normative standards as to the proper attitudes to express regard-

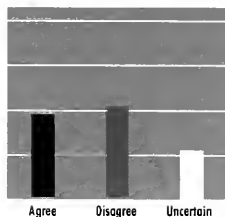
<sup>9</sup> In obtaining the median, we rank the individual scores and take the middlemost one. When the number of scores is even, we average the two middle ones to obtain the median. (See the Statistical Appendix.)



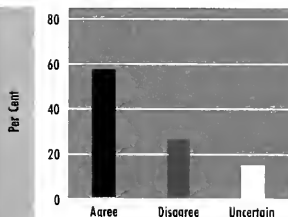
Obedience and Respect for Authority are the Most Important Virtues that Children Should Learn.



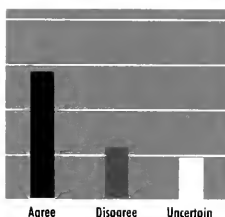
A Large Mass of the People are Not Capable of Determining what is and what is Not Good for Them.



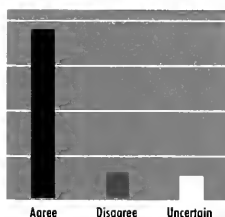
The Right of Some Working Groups to Call a Strike Should be Abolished, as it is a Threat to Democracy and Not in the General Interest of Society.



The Police or F.B.I. May Sometimes be Right in Giving a Man the "Third Degree" to Make Him Talk.



The Average Citizen is Justified in Remaining Aloof from Dirty Politics that May Exist in His Community.



The Most Serious Danger to Democracy in the United States Comes from Communists and Communist-Dominated Groups.

**6.11 Some Expression of Teenage Attitudes.** These are reactions to a few of the many items in this study. The numbers represent the per cent answering as indicated. (From Remmers, H. H., and D. H. Radler, "Teenage Attitudes," *Scientific American*, June 1958, pp. 26-28.)

ing . . . 'Negroes moving in next door' or 'Having a Negro doctor.'"<sup>92</sup> The investigators felt that, although absence of prejudice toward Negroes is expected and expressed in such a community, there is the possibility that "covert feelings to the contrary" might exist.

Sixteen days after doing the "Verbal Intelligence Test" the same students were asked to fill in a "Personal and Social Attitudes Record" which they were led to assume would be filed in the office along with their other records. The items in this questionnaire were comparable to those of the other test but each was framed directly. That is, the student said,

in each case, what *she* would do under the stated circumstances. There was no time limit.

One interesting outcome of this study is illustrated in Figure 6.12. The upper histogram represents the frequency of completions on the ten projective Negro items which, in the opinion of judges, were negative or prejudicial to Negroes. Observe that there is a wide distribution of negative attitudes—one of the group gave no negative reactions, three gave one negative reaction, and so on. At the other extreme were three who reacted negatively to all ten items. We see, then, that the private attitudes of this group differed widely. But

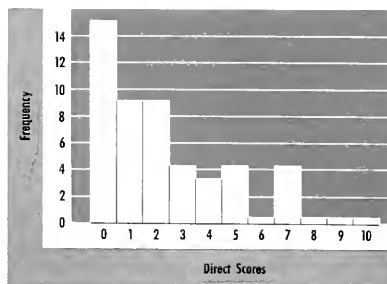
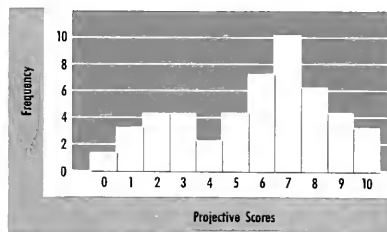


how about the attitudes which were to go on record and be identified with the person who expressed them? The outcome here was very different from the above. Instead of a wide distribution, suggesting a normal curve, there was a markedly skewed distribution. Most reactions were in a direction favorable to Negroes. Fifteen students, for example, gave no negative reactions, nine gave only one negative reaction, and so on. No subjects expressed prejudice to the extent that they gave negative completions for all ten items. On noncontroversial items the distribution was similar regard-

less of whether the projective or direct form of the test was used.

A skewed distribution like that obtained for the Negro items is commonly found when individuals react openly to controversial issues. Because of its shape (a reversed J) this is customarily referred to as a J-curve. It represents the trend toward conformity such as that already revealed in the study of teenage attitudes—which, one will recall, were expressed anonymously. There is no doubt that even greater conformity would have been revealed by a direct test such as that used here.

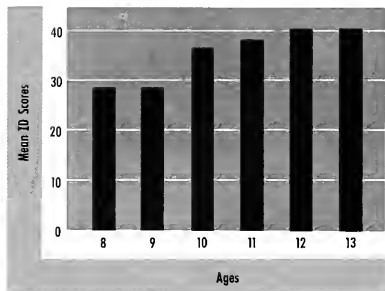
**6.12 Comparison of Projective and Direct Attitude Scores.** Each column represents the frequency of the indicated number of negative (i.e., prejudiced) responses. Note the reversed J shape of the lower curve. (From Getzels, J. W., and J. J. Walsh, "The Method of Paired Direct and Projective Questionnaires in the Study of Attitude Structure and Socialization," *Psychological Monographs*, 1958, 72, No. 1, p. 15.)



### Children's attitudes

The investigators who studied attitudes in college students as described above subsequently made an extensive survey of children's attitudes.<sup>93</sup> More than 900 children ranging in age from 8 to 13 years were tested. The method was similar to that described except that the items were simpler and the instructions were modified to adapt them to children. In the *direct* type of test, the children were asked to say how they would behave if certain things happened to them. Corresponding projective items were given as part of a test "to see how fast you can make sentences." In each projective item, however, the behavior was attributed to Jane, Mary, or some other person named in the item. The items had reference to such issues as cheating, religion, race, belief in God, honesty, and helping others.

In this investigation an index of differentiation (ID) was derived from the direct and projective responses. It represented the discrepancy between the personal attitude (as revealed by projective responses) and the overtly expressed attitude (as revealed by direct responses). It was predicted, on the basis of what is known about the socialization of children, that the ID would increase with age. This is what did happen, as illustrated graphically in the bar graph of Figure 6.13. This increase in the ID with age came about because the children's personal attitudes underwent greater suppression as they grew older. Their personal attitudes, as indicated by the projective reactions, did not change appreciably. At successive yearly age levels from 8 to 13, for example, the mean projec-



**6.13 Mean ID Scores for Children from 8 to 13 Years of Age.** The figures at the left are mean ID scores (see text) to the nearest whole number. There were from 133 to 174 children in each age group. (Data from Getzels and Walsh.)

tive scores were 18.04, 17.33, 18.62, 18.73, 18.83, and 18.73 — a difference between the lower and upper age levels of only .69 points. The direct scores, however, decreased between the 8th and 13th years as follows: 13.23, 12.40, 11.71, 11.12, 10.99, and 10.83.

It is interesting to note that the tendency to suppress overt expressions of personal attitudes was significantly more marked in girls than in boys, in only children than in those with siblings, and in children from homes of

high socio-economic status than in those from homes of low socio-economic status. These outcomes had been predicted on the basis of other information concerning the relative degree of socialization in these groups.

One should not gather from what has been said above that all individuals, in becoming socialized, are “brain washed” into conformity. This is obviously not the case. Some react negatively to social pressures and even pride themselves on their nonconformity. There is, however, a predominant trend toward conformity, so much so that some observers have become concerned about what this may do to our democratic way of life. A certain amount of conformity is essential. Without it we would have anarchy. But when an individual dare not speak out on controversial issues for fear of losing friends or of suffering reprisals, there is a serious defect in social relations. This is stressed by the investigators of teenage attitudes, who say:

Ralph Waldo Emerson pointed out that the price of group agreement is descent to the least common denominator. As T. V. Smith and Eduard Lindeman remarked in their book, *The Democratic Way of Life*, a democracy cannot afford to devalue “the finality of the individual,” from whom “all things flow.” In our view, the future of democracy is not promising unless we restore a social climate which will reward independent thinking, personal morality and truly enlightened cooperation in place of going along with the crowd.<sup>94</sup>

## Summary

All organisms have physiological needs — need for food, liquid, elimination, and so on. When such needs are not readily satisfied, the organism is driven to activity. This is the basis for speaking of physiological drives — such as the hunger drive, thirst drive, excretory drive. A drive may set in operation, more or less automatically, the activities which alleviate or reduce it. Examples of this process (homeostasis) are found in regulation of body temperature, urination, deeper breathing

(sometimes larger lung capacity) in oxygen-deficient air. Not all drives are homeostatic. Indeed, some (liking of sweetness, for instance) are satisfied artificially (saccharin) even though no physiological homeostasis results. The stimulation drives (curiosity, exploratory, manipulatory) are also nonhomeostatic, at least in the physiological sense. However, the term “homeostasis” has been extended by some to represent any form of readjustment or compensatory activity.

The hunger drive may be reduced by food in the mouth and in the stomach, even before there has been time for a change in blood chemistry. Thus reduction of the hunger drive is not necessarily the same as need reduction, the restoration of normal blood chemistry. Studies of semistarvation have shown that hunger may subvert man's cultural ideals.

Thirst is a drive initiated by cellular dehydration. It is often experienced as dryness of the mouth and throat.

The sex drive has been shown to be related to secretions from the gonads (ovaries and testes), although the drive is disturbed by injury to the anterior pituitary gland and to the cortex of the adrenal glands.

In females the sex drive is dependent, initially at least, upon estrogens (from the ovaries). In males, the corresponding secretions are androgens (from the testes). Although the human sex drive has the same physiological motivation as that of other animals, it shows much wider variation both in intensity and in direction of satisfaction. Social influences are largely responsible for such variation.

Whether infants have a "need" for affection, as some have claimed, is in doubt because the evidence is from infants also denied normal stimulation. Human adults denied such stimulation show adverse effects. Associated with this apparent "need for stimulation" or "to know the environment," there are exploratory and manipulatory drives. These have been demonstrated in rats, monkeys, chimpanzees, and human subjects.

Instincts are complex unlearned patterns of reflexes. We see many instances where animals satisfy their physiological needs instinctively. The mating and maternal behavior of rats illustrates this relation between need and instinct. The point was stressed that, as our study shifts from rat to man, we find decreasing evidence of instincts. While mating in the rat is clearly an instinct, developing in the same way even under conditions of isolation, the mating of chimpanzees is not clearly so. When the human level is reached, one observes even less evidence of an unlearned mating pattern. In the case of maternal behavior, it is even doubtful whether human beings have a physiologically determined

maternal drive. The specific patterns of human maternal behavior, except possibly for suckling at the breast, are learned.

Many human motives are acquired in social situations as the outcome of personal experience, hence the term personal-social. Some of these have no obvious relation to physiological drives although they do have a basis in anticipation of physiological emergencies. Frustration of physiological needs (as in the case of hunger) may reduce human behavior to a less civilized level.

Personal-social motives are in some instances acquired universally. This is because, despite cultural diversities, all human beings are exposed to certain environmental influences. All are, initially, helpless, all depend upon social contacts for survival, all are positively conditioned to those who are instrumental in satisfying their early needs, all learn to appeal to others for help, and all learn the advantages of copying certain aspects of the behavior of those around them. These similarities give rise to such coenotropes as gregariousness and appealing to others when in need.

Some motives are characteristic of a particular culture. Thus the typical American is self-assertive, with a strong achievement motive, while the Arapeš is submissive. The individual origin of such motives goes back to childhood training.

Motives also vary from one person to another. Thus the self-assertiveness found so predominantly in our own culture has various individual manifestations. In addition to personal variations in universal and common forms of motivation, there are motives which, in their nature, vary from one individual to another. These personal motives include such things as the desire of one to be a doctor, of another to be an engineer; of one to gain world-wide recognition and another to avoid publicity, and so on.

Personal aspirations depend upon experiences of success or failure, sometimes going back to early childhood. Experimental studies on levels of aspiration have shown that success tends to raise the level and failure to lower it.

Some habits seem to acquire the status of drives, i.e., to become independent of their original motivation. This is referred to as functional autonomy. Persistence of particular

ways of satisfying a motive is distinguished from functional autonomy because the motive as well as the habit persists. This is known as force of habit.

Many motives which influence behavior, as well as the origins of them, are unrecognized by the individual whose behavior they influence. We say, therefore, that he is not conscious of them, or that they are unconscious. Motivation covered by the term id was regarded by Freud as completely unconscious. The ego and the superego are only conscious in part. Unconscious motivation is illustrated by phobias whose origin is unknown to the person who has them, by response based upon post-hypnotic suggestions, attitudes of obscure origin, and slips of the tongue.

Appropriate incentives increase human effort. Monetary incentives play an important part in our culture. The worker who feels that his employer is interested in him personally (the Hawthorne study) is likely to be well-motivated in his work.

Interests and attitudes predispose us to react in different ways to the same external

situations. Interests are positively directed, are directed toward specific goals, and are active, or dynamic. Attitudes may be positive or negative in direction. Negative attitudes are what we customarily refer to as prejudices. Racial prejudices are usually acquired in childhood as part of the social heritage. Experimental studies show that there is a tendency for children who are most prejudiced to be rigid rather than flexible in their thinking.

Attitude research has shown the presence in our society of a strong "drive to conformity" and a related desire to be popular. Projective and direct studies of attitudes toward controversial issues show that overt attitudes (direct expressions) tend to conform to the prevailing social climate and yield a J-curve. Private attitudes (projectively revealed) approximate a normal curve. In children, the discrepancy between private and public attitudes (differentiation index) increases with age. This is not because private attitudes change a great deal in the age-range studied (8-13) but because public expression of them is suppressed as the child grows older.

(References and notes for this chapter are on page 547 of the Appendix.)

## Selected Readings

- Bindra, D., *Motivation*. Ronald, 1959. A systematic review of recent literature on motivation.
- Birney, R. C., and R. C. Teevan, *Instinct*. Van Nostrand, 1961. A book of readings on this topic.
- Daniel, R. S., *Contemporary Readings in General Psychology*. Houghton Mifflin, 1959. Part VI, which deals with various dynamic aspects of behavior, has some papers that are relevant here.
- Hall, J. F., *Psychology of Motivation*. Lippincott, 1961. A survey of the constructs, theories, and research on motivation.
- Hebb, D. O., *A Textbook of Psychology*. Saunders, 1958. Chapter 8. A brief but interesting discussion of needs, drives, and emotions, with some angles not covered in this chapter.
- Jones, M. R. (Ed.), *The Nebraska Symposium on Motivation*. University of Nebraska Press, 1953-1960. This symposium has appeared every year since 1953 and each issue contains a series of lectures by leaders in motivational psychology.
- Klineberg, O., *Social Psychology* (Rev. Ed.). Holt, 1954. Chapters 4 and 5 review what is known about human nature and the motives discussed in this chapter. Attitudes and prejudices are discussed in Chapters 18 and 19.
- Marcuse, F. L., *Hypnosis*. Penguin Books, 1959. This will answer the student's questions about hypnosis.

- Munn, N. L., *Evolution and Growth of Human Behavior*. Houghton Mifflin, 1955. Chapter 3 (unlearned behavior).
- McClelland, D. C., *Studies in Motivation*. Appleton-Century-Crofts, 1955. Part III (Social origins of motives and values, written by various authorities) is an especially good supplement to this chapter.
- McGuigan, F. J., and A. D. Calvin, *Current Studies in Psychology*. Appleton-Century-Crofts, 1958. Chapter II has several rewritten and somewhat simplified reports of experimental studies on motivation, including a report by Olds and Milner on pleasure and pain areas in the brain. Reading 24, based upon the research of Bexton, Heron, and Scott on effects of isolation is also relevant.
- Schachter, S., *The Psychology of Affiliation*. Stanford University Press, 1959. Experimental studies on the sources of gregariousness in human beings.
- Scott, J. P., *Aggression*. University of Chicago Press, 1959. This discusses the causes, control, and consequences of aggression and it has a good list of references on early studies of aggressive behavior.
- Stacey, C. L., and M. F. DeMartino, *Understanding Human Motivation*. Howard Allen, 1958. Over 40 papers on various aspects of motivation, including all of those discussed in this chapter. The papers first appeared in psychological and sociological journals.
- Stevens, S. S. (Ed.), *Handbook of Experimental Psychology*. Wiley, 1951. See especially Chapters 6 (homeostasis, by Dempsey), 12 (instinctive behavior, by Beach), and 13 (learnable drives and rewards, by Miller).
- Woodworth, R. S., *Dynamics of Behavior*. Holt, 1958. Chapters 2-5 deal, in an interesting way, with various aspects of motivation.
- Woodworth, R. S., and H. Schlosberg, *Experimental Psychology* (Rev. Ed.). Holt, 1954. See Chapter 22, which surveys experimental investigations of motivated behavior.

# Emotional Motivation



Emotions and motives • Feeling and emotion • Physiological aspects of feeling and emotion • Emotion as a function of the whole organism • Emotional development • Situational aspects of emotional development • Fear and anxiety • Anger and aggression • Smiling, laughter, and humor • Happiness and affection • Sympathy • Summary

The terms *emotion* and *motivation* have a common derivation. The Latin word *emovere* means to stir up, agitate, excite, or move. To be *moved* in an emotional sense means to be “stirred up.” In a motivational sense it means to “bestir oneself” or to “be pushed.” Sometimes emotion not only stirs us up but also causes us to bestir ourselves. Moreover, it may impel us to say and do things which we would not normally say and do.

When emotion is intense there are widespread changes which embrace every aspect of our body and its activity. Physiological and neural processes are altered. Thoughts and actions are affected. Marked disorganization may occur. What we were doing may be dropped; even forgotten. Overall adjustment may be disturbed. In an emotion-provoking emergency we may exhibit unusual energy; or we may be “rooted to the spot” or “lose our heads.”

But emotional life is infinitely varied and it has integrating as well as disintegrating aspects. Variation can be seen not only in the intensity of emotional activation but also in emotional experience and in external expressions of emotion — in emotional feeling as observed in oneself and as reported by others, in facial expressions, in gestures, and in overall behavior patterns.

Looked at from the *intensive* angle, emotion is merely a sort of physiological, neural,

and experiential activation. Thus it may be said<sup>1</sup> that "the angry man overreacts to stimulation"; that "Strong emotion . . . represents one end of a continuum of activation"; and that "The opposite end, the condition of minimal activation, is found in the sleeping man, who does not react to stimulation." Emotion is not essentially different, in this respect from tensions associated with physiological drives. Indeed one psychologist<sup>2</sup> calls emotion a form of "energy mobilization" and she attempts to identify it with other motivational phenomena.

When we consider emotion from the standpoint of activation or energy mobilization, disrupting emotion is of course nothing more than exceptionally strong emotion. But intensity of activation is not the most characteristic aspect of emotion. The emotionally aroused person will tell you not only that he is slightly or strongly excited but also that he has such and such an *emotion*. He will say that he is afraid, angry, jealous, or in love.

There are many emotional experiences and many forms of overt emotional behavior over and above the intensity variations. Any dictionary contains many terms to represent these different emotions. A checklist used in research has over one hundred adjectives — amused, annoyed, cheerful . . . tense, unhappy, worried — to indicate how emotionally aroused people feel.<sup>3</sup> There are also many adjectives to describe overt emotional behavior — affectionate, aggressive, belligerent, entreating, and so on.

How do we know, for example, that a person is not only aroused intensely but that he is afraid, or angry, or in love? The answer is that the subject says in one instance that he is afraid and in the other that he is angry. We may observe, too, that different stimuli are present in each case, that the general situation is somewhat different, and that different overt behavior occurs. To make him afraid we may fire off a revolver behind his head, put a snake or a rat in his hands, or make his chair collapse suddenly. But to make him angry we tell him that we are not going to pay him what we owe him, that we are going to fail him in the course, or that somebody has made derogatory remarks about his honesty. When the stimuli are fear-provoking, the subject jumps back, tries to get away, or screams. When they are anger-provoking, on the other hand, he argues, makes threats, or strikes the offender. Even when no such actions are elicited, the situation may bring out different facial expressions which we have learned to interpret as representing particular emotions. The reader might attempt to name the unposed emotions represented in Figure 7.1 and also describe the sort of situation that he thinks may have precipitated them.

We do not wish to infer that one can find experiential and behavioral differences to verify every emotional term in the language. As in the case of intensity, there is an almost imperceptible gradient between so-called *emotions*, or what might better be referred to as *ways of behaving emotionally*. The well-recognized emotions are those which stand out, like mountain peaks, from the general emotional terrain. They stand out because they are quite often intense and because they have clearly recognized experiential and behavioral aspects. These are the emotions most easily recognized in ourselves, most easily expressed in our language, and most easily identified when we see them represented in pictures or on the stage. They are also most readily predicted in terms of the situations which arouse them. We can predict, for example, that fearful behavior will probably be elicited by a gun poked into one's ribs and that anger will most likely occur if strong motives are frustrated.<sup>4</sup> It is in terms of such emotions, moreover, that emotion has often been defined as disturbing and disorganizing in its effects.

The emotions most obvious to the poet, the novelist, the dramatist, and the casual observer of himself and others are, however, no more truly representative of emotion in general than the mountain peaks in a terrain are truly representative of its geography. Most of our everyday emotional life is no more obvious than the physiological drives



**7.1 Some Unposed Emotional Expressions.** What emotions are expressed? What kind of situation precipitated each? After answering these questions, refer to page 490. (Press Herald Evening Express, *Life*, © Time, Inc., Rosen Studios, Sydney Morning Herald, Herb Gehr, from Black Star.)



and other motives already considered. We may go for days, or even weeks, without any obvious expressions of emotion yet never be free from emotional undercurrents which influence our perceptions, our interests, our attitudes, our prejudices, our thoughts, our learning, and all of our actions.

## EMOTIONS AND MOTIVES

In some respects, the emotional undercurrents of life, together with the more obvious emotions, are comparable with physiological motives. They may actually have evolved from such motives, thus facilitating adjustment.

### Evolution of emotional behavior

Darwin<sup>5</sup> and later writers on evolution stressed the value of emotion for survival and they presented evidence that human emotions have animal origins. But at what level of animal life did emotions emerge and from what earlier behavior did they take their departure? The answer is that nobody knows. We have no way of communicating with animals to learn whether they have emotional experiences and we cannot, with any degree of assurance, infer emotions from their behavior. We may infer that apes, monkeys, and dogs have emotions somewhat like ours because we see resemblances between their behavior and our own under comparable circumstances. As we go down the scale, however, such inferences become increasingly difficult and more highly speculative. Nevertheless it has been claimed that emotions, at whatever level they emerged, took their departure from physiological motives. The proponent of this theory<sup>6</sup> suggests that a clam is motivated, but presumably without emotion. Somewhere above this level, he says,

Animals became more complex in their receptor equipment, motor equipment, and capacity for learning. As such complex creatures developed, those that were motivated merely by the long-established physiological motives were not so well equipped for survival. The animal that did not make avoiding responses until it was grabbed by an enemy was less likely to survive than an animal capable of reactions of fear that would be set off by relatively slight stimuli. The animal that had an interest in its offspring — even in the case

of the male and in the case of the female even beyond the period of nursing the young — was more likely to reproduce its kind.

Whether emotions evolved from physiological motives or originated in some other way, it is clear that they have motivational significance and, under certain circumstances, also an evident survival value. Like physiological motives, they impel us to activity. They also engender goal-oriented activities, like the lover's affectionate behavior toward the loved one and the angry man's aggression toward the object of his anger. Some arouse the escape motive. Fear exemplifies this fact. Annoyance, also, may motivate escape from the thing or person that annoys. Sometimes emotions "move" us to tears, or to the performance of sympathetic or charitable acts.

Attention has already been called to the energizing role of physiological drives — to their arousal of tensions demanding that we do something about them — and to the fact that the conditions associated with emotion activate the bodily mechanisms, creating internal tensions.

### Emotion as a source of energy

The energizing function of emotion, which is probably always present to some degree, is quite obvious in certain emergencies.<sup>7</sup> It is then that emotional activation most clearly has survival value. Take for example, fear aroused in situations requiring struggle or escape. The physiological conditions associated with this emotion may provide "super-human" energy or "lend wings" to our feet. This is because the medulla of the adrenal gland (Figure 9.4, p. 240) gives forth an excessive supply of adrenalin which, among its other effects, causes the liver to release stored up glycogen (a form of sugar).<sup>8</sup> If emotional activation is too intense, however, fear may paralyze action; "rooting" us to the spot, "freezing" us in our tracks, or making us "leaden footed." Indeed some animals are

literally paralyzed by sudden, threatening stimuli. We speak, then, of "tonic immobility" or "animal hypnosis."<sup>9</sup> Paralysis under these conditions may actually have survival value. Many animals, although they have poor vision for certain aspects of their environment, are quick to sense the slightest movement. Thus the motionless prey is relatively safe. But we could hardly claim such an emergency value for comparable conditions in man, except in the jungle.

Although the physiological correlates of emotion may energize in the sense that physiological drives energize, they do not appear periodically, as do the conditions underlying hunger and thirst. This is because they are not dependent upon recurring physiological needs. The most obvious emotional episodes are, as we have seen, usually *acute*. They are isolated occurrences which do not depend for their arousal upon changes within the body. Rather, they are dependent upon circumstances—a feared object appears, somebody says or does something which angers us, what we observe makes us envious or jealous, the time nears for an important event and, with fear or joy, we anticipate its arrival.

In addition to acute emotional episodes contingent upon such occurrences as we have mentioned, there are also *chronic* emotional states. There may be prolonged anxiety, depression, or elation. Sometimes an emotion-provoking situation is itself prolonged; as on the battlefield, or in a home where there are continued frustrations. Quite often, however, such prolongation of emotional states has symbolic support. That is to say, one *remembers* and dwells upon past provocations, he *imagines* that his wife is unfaithful, or he *anticipates* failure. This tendency of man to live in the past and to project himself into the future is attributable in great measure to his possession of words to represent the past and the future. It is indeed true that man fears many things which never happen and that, as Thoreau wrote in his *Journal*, "Nothing is so much to be feared as fear itself."<sup>10</sup>

Emotion infiltrates many aspects of human

life. It is an important aspect of frustration and conflict, to be considered in the following chapter. Some chronic emotional states, like prolonged anxiety, may be regarded as personality traits. Susceptibility to emotional provocation also differs greatly from one person to another and it is an aspect of temperament. These involvements of emotion in personality are considered later (Chapter 9) in that context. In the chapters on learning we shall have occasion to consider how emotional motivation contributes to this process. Our discussions of thinking, attending, and perceiving will give further emphasis to the motivating role of emotion.

## FEELING AND EMOTION

To the emotionally aroused individual himself, the most obvious aspect of emotion is feeling. He experiences "butterflies" in his stomach. His "heart sinks" within him. He has his heart "in his mouth." He feels hot or cold, excited or calm, tense or relaxed, happy or sad. What he hears and reads supports his belief that such feelings, rather than being peculiar to his own experience, are universal aspects of emotion.

### Subjective nature of affective processes

The subjective nature of feelings, or of "affects," as they are called technically, is a major obstacle to scientific investigation. Nevertheless a great deal is known about affective experience indirectly, through observations of it in ourselves and consideration of what other people tell us about theirs. We know, for example, that some emotions, like fear and anger, are unpleasant while others, like happiness and love (except when frustrated), are pleasant.

When subjects are emotionally aroused, as in Figure 7.2, their descriptions of experiences are extremely meagre. About all they do is to name their emotions. Thus girls who were forced to crush a snail between their fingers said merely that the act was repulsive, distasteful, disgusting, or unpleasant.

More information is obtained when, instead of depending upon their own vocabulary, subjects use a check list of such affective items as pleasant, unpleasant, exciting, tension-pro-

<sup>9</sup> This is perhaps the inspiration behind President Franklin D. Roosevelt's famous statement in 1933, following the financial collapse, that "The only thing we have to fear is fear itself."

ducing, and so forth. What one learns from such studies, if he doesn't know it already, is that *fear* is unpleasant and exciting, with tension and strain involved; that *joy* is pleasant and bright; and that *sorrow* is unpleasant, depressing, and dull. The feelings cited most frequently, and with greatest uniformity from one subject to another, are pleasantness and unpleasantness. Indeed it is relatively easy for them to classify their emotions into the predominantly pleasant and the predominantly unpleasant.

In studies of facial expression in emotion, where subjects are asked to name the emotion expressed, the terms applied to a particular expression may differ considerably. Nevertheless, there is seldom any doubt as to the pleasantness or unpleasantness of the experience behind it. Observe, for example, the posed facial expressions, in Figure 7.3. It is not at all difficult to discern a gradual transition in pleasantness, as the reader will find if he does the exercises described.<sup>10</sup>

### The pleasure principle

It has been maintained by many philosophers of human nature that pleasure is the ultimate goal of life; that all activities are motivated by the pursuit of pleasure and the avoidance of pain.

Freud made the *pleasure principle* a basic postulate in his theory of human motivation. According to this principle, our physiological drives (*id*) come, in course of time, to be controlled by the self (*ego*). This has developed to act "as an intermediary between the *id* and the external world." The *ego's* activities "are governed by consideration of the tensions produced by stimuli present within or introduced into it. The raising of these tensions is in general felt as *unpleasure* and their lowering as *pleasure*. It is probable, however, that what is felt as pleasure or unpleasure is not the *absolute* degree of the tensions but something in the rhythm of their changes. The *ego* pursues pleasure and seeks to avoid unpleasure. An increase in unpleasure which is expected and foreseen is met by a *signal of anxiety*; the occasion of this increase, whether it threatens from without or within, is called a *danger*."<sup>11</sup>

Many who are not Freudians also empha-



**7.2 Emotional Expressions Aroused Experimentally.** These expressions were aroused (top to bottom, respectively) by electric shock, crushing a snail, and the proximity of a snake. (From Coleman, J. C., "Facial Expressions of Emotion." *Psychological Monographs*, 1949, No. 296, pp. 10-11.)



**7.3 Some Posed Emotional Expressions.** Arrange these into a sequence from the unpleasant to the pleasant, then check with the data on page 490. (Courtesy Harold Schlosberg.)

size the motivating function of pleasure and pain. We find aspects of the pleasure principle involved in theories of learning (see Chapter 10) and also in a recent theory of motivation<sup>12</sup> where a motive is defined as "a strong affective association, characterized

by an anticipatory goal reaction and based on past association of certain cues with pleasure or pain."<sup>13</sup> This implies that when our acts produce pleasurable results, there develops a tendency to repeat these or comparable acts, the aim being to gain a repetition of the

pleasure associated with them. What motivates us, under such circumstances, is *anticipation* of the results of such activities. Anticipation is of course learned. Take happiness or pleasure, for example. "When the person is experiencing it we call it an emotion, but if it or the conditions producing it give rise simultaneously to anticipations of a change in affective state (either an increase or decrease in pleasure, or increase or decrease in pain), then a motive may be said to be involved. In short, it is the anticipatory goal response or reintegrated [remembered] change in affective state which gives the motive its *directing* power as compared with an emotion which is an affective arousal *now* with no associated reference to another affective state."<sup>14</sup>

The deterrent function of unpleasant affective states may be given a comparable interpretation. Experiments on the startle reaction in human beings may be used to illustrate this. In these experiments, ultrarapid movies pictured the changes in facial and postural expressions following an unexpected revolver shot. The initial reaction (see Figure 7.4) was uniform from one subject to another. It was followed, however, by reactions which differed from person to person—such reactions as blinking the eyes, turning, and moving away. In interpreting these outcomes in accordance with the theory under discussion, its author points out that the relatively slow and varied reactions which follow the initial response to a loud noise are expressions of an *avoidance motive*. They are slow and varied because they depend upon learned modifications at higher levels of the brain than those which mediate purely reflex responses. He points out, however, that certain other strong stimuli, like those which produce pain, become associated so frequently and early in life with painful consequences that they cue off motivational associations with great dependability; i.e., responses which resemble the quick and stereotyped reflex response to a loud noise.<sup>15</sup>

We see, therefore, that affective processes may have motivational significance. Some, like sudden noises, injuries, and foul odors are inherently unpleasant; others, like bodily warmth, are perhaps inherently pleasant. Drive reduction is pleasant; drive frustration



**7.4 The Startle Pattern.** This expression, which is remarkably uniform from one person to another, has been photographed with cameras running from 64 to 2200 exposures per second. The stimulus was a revolver shot. "The first and most notable feature of the facial pattern is the immediate closing of the eyes. Then there is a widening of the mouth as though in a grin, although this only occasionally leads to a real baring of the teeth. The head and neck are brought forward. Sometimes, as the head comes forward and down, the chin is tilted up so that the features are still directed straight ahead despite the movement. The muscles in the neck stand out. . . . It is even possible in rare instances, to notice a twitching movement in the scalp and ears." Although certain aspects of this pattern may be absent on some occasions the eye-blink is always present. (After Landis and Hunt.)

unpleasant. The objects, persons, and situations associated with these consequences acquire relevant affective value. We react to them positively or negatively depending upon their respective pleasant or unpleasant associations, and our anticipation of such affective outcomes. Objects, persons, and situations without affective associations arouse neutral reactions.

A knowledge of what commonly pleases people is of great practical value to adver-

tisers and others who wish to influence our behavior. Some of the relevant research has dealt with the affective value of colors, tones, and odors.<sup>16</sup> Investigators have also studied various aspects of aesthetic appreciation, especially as it relates to literary, pictorial, and musical arts.<sup>17</sup> Even the things which commonly annoy people have been subjected to intensive study. One outcome has been the discovery that people are annoyed more frequently by what others do and say than by nonhuman objects and events.<sup>18</sup>

#### PHYSIOLOGICAL ASPECTS OF FEELING AND EMOTION

Some of the physiological concomitants of emotion are evident in everyday experience. Palpitation of the heart, accelerated breathing, a sinking feeling in the stomach, sweating, trembling and many other organic phenomena are commonly-reported aspects of emotion. Thousands of men in the armed services have reported organic symptoms of fear aroused in combat situations.<sup>19</sup> The most commonly mentioned symptom is a pounding heart. Other symptoms with a high frequency of occurrence are also indicated in Table 7.1.

Many organic concomitants of feeling and emotion have been investigated instrumentally, as illustrated in Figure 7.5. The so-called *lie-detector* is an adaptation of similar devices. What it detects, actually, is physiological reactions in emotion. It contains instruments to record changes in heart action, in respiration, and in electrical conductivity of the skin—the galvanic skin reflex, or GSR.\* These changes are recorded on a moving polygraph tape. The person taking a lie-detector test is required to answer questions, some of which are relevant and others irrelevant with respect to a crime. It is assumed that the criminal will be more emotionally aroused by the relevant than by the irrelevant questions, hence “give himself away.” The innocent person, on the other hand, will not “see the point” of the relevant questions (unless he knows the details of the crime) and he will thus react no more emotionally to them than to the irrelevant ones. The lie-detector is not

Table 7.1 Emotion in Aerial Combat \*

These are the symptoms most often reported in a group of 4,504 flyers returned from aerial combat missions.

Symptom	Per cent reporting
Pounding heart	86
Muscular tenseness	83
Irritability	80
Dryness of throat and mouth	80
Cold sweat	79
Butterflies in stomach	76
Feeling of unreality	69
Frequent urination	65
Trembling	64
Confused and rattled	53
Feeling weak or faint	41
Poor memory for what happened on mission	39
Feeling sick to stomach	38
Poor ability to concentrate	35
Wetting or soiling pants	5
The following are delayed effects:	
Tired out	92
Restlessness	89
Feeling depressed	80
Jumpy at loud or sudden noise	76
Grouchiness	65
Poor appetite	63
Bad dreams	58

fool-proof, however, and its results are not readily admitted as legal evidence of guilt or innocence. Nevertheless, it has been quite useful in narrowing the field of suspects and in persuading many criminals to confess.<sup>21</sup>

Devices like those involved in the lie-detector have also been used in attempts: (1) to differentiate emotional from nonemotional states, (2) to discover the degree of emotional activation, and (3) to discern physiological differences in emotions like fear and anger.

#### Emotion versus nonemotion

One attempt to differentiate emotional from nonemotional states in terms of their physiology was that in which emotion-provoking

\* This change in conductivity is a function of sweat gland activity.<sup>20</sup>

\* From Shaffer, L. F., “Fear and Courage in Aerial Combat.” *J. Consulting Psychology*, 1947, 11, 139.



**7.5 Measuring Some Physiological Concomitants of Emotion.** The polygraph is registering the onset of the stimulus and also seven aspects of physiological reaction. Electroencephalograms (brain waves) are being picked up from the instrument on the subject's head. The pneumographs around her chest and abdomen provide records of thoracic and abdominal breathing. Below one knee is a sphygmomanometer, which picks up changes in pulse rate as well as blood pressure. Changes in electrical resistance of the skin are picked up from electrodes on the hand and sent into a psychogalvanometer connected with the recording polygraph. Changes in skin temperature are also recorded. An instrument for picking up tremors in the fingers may be used. A wire recorder is shown at the extreme right. (From the Harvard University Department of Social Relations. Photo courtesy LOOK Magazine.)

stimulation was provided by collapse of a chair.<sup>22</sup> Eighteen college students volunteered to serve as subjects in what was ostensibly a study of heart action. One at a time, they sat in the dark with devices attached to them which recorded heart activity, respiration, and the GSR. In control sessions, the chair did not collapse. Thus records of normal functions were obtained. Then, under conditions which were otherwise similar to those already experienced, the chair suddenly fell backwards, its fall being absorbed by a door stop. All subjects reported fear and most of

them yelled, called for help, or tried to escape. In later sessions the subjects were sometimes told when the chair was going to collapse, and sometimes not. When they knew that a collapse was imminent, there was no fear. Fear was thus reported only whenever the chair collapsed without warning. Physiological changes occurred under both conditions. Sometimes, as in the case of the GSR, they were alike whether or not fear was present. Some other indices did, however, reveal consistent differences. The initial acceleration of the heart, for example, was 16 per cent with

fear and 10 per cent without; the duration of the change in respiration was three minutes under the first condition and only one minute under the second.

In experiments like this the psychologist knows whether or not there is an emotion, irrespective of the physiological records. He knows because the subject tells him so, or because he can predict that the stimuli used will produce an emotional response. But suppose we should give the psychologist no other information than that provided by the physiological records alone? Could he tell whether or not an emotion had occurred? The chances are that he could not. This is because similar changes are also elicited by mental and physical work. Thus, although one could observe that physiological changes had occurred, he could not tell whether they resulted from emotion or from work.

Electroencephalograms (brain waves) offer a further approach to the physiology and neurology of emotional as compared with non-emotional states. It has been shown (Figure 7.6) that there is a marked difference between the electroencephalograms (EEG's) obtained

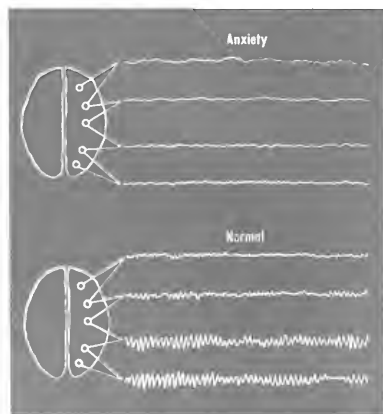
from the same subject under conditions of apprehension and relaxation.<sup>23</sup> When the subject is brought in and preparations for taking EEG's are in progress, he is usually "tense, worried, and generally apprehensive about the procedure." The initial records show poorly developed rhythms. "After a few minutes of recording, the subject usually quiets down and assumes a relaxed state, with the result that . . . the alpha waves are well developed and of considerably greater magnitude than in the initial record." It is pointed out, however, that a blocking of the rhythms similar to that associated with apprehension may be produced by "discrete sensory stimuli." Thus one could not, from these effects alone, tell whether emotional activation was responsible.

#### Intensity of emotional activation

The *intensity* of affective experience and the magnitude of physiological changes are demonstrably related. Increases in affective intensity may be gauged through the subject's rating of the intensity of his experience and also through intensity of stimulation—such as the severity of an electric shock. The magnitude of the GSR has been shown to increase with the reported intensity of pleasant and unpleasant experience.<sup>24</sup> Those stimuli which the subject rates as pleasant or unpleasant usually arouse a more pronounced reaction than those rated as neutral in affective value.<sup>25</sup> Moreover, a high intensity of emotion, as indicated by verbal reports, is associated with a more marked GSR than is a weak intensity of emotion.<sup>26</sup>

### 7.6 EEG's of Normal and Anxious Subjects.

Only a portion of each record is shown. The separate waves are picked up from different areas of the brain. Normal and anxious states are not always so clearly differentiated as in this instance, but the effect of anxiety, if oppoent, is to flatten the waves as illustrated. (From Lindsley, D. B., "Emotion" in S. S. Stevens (Ed.), *Handbook of Experimental Psychology*. Wiley, 1951, p. 499.)



#### Differentiating emotions

Do the physiological concomitants of different emotions, like fear and anger, also differ in any measurable way? There is some evidence suggesting the possibility of certain physiological differences, but these are not, as yet, clearly established.

Differences in stomach activity associated with fear, on the one hand, and anger or resentment, on the other, were observed in a clinical case.<sup>27</sup> This subject and one of the doctors who carried out the investigation described here are shown in Figure 7.7 together with a record of stomach contrac-



tions in serenity and anger. The subject's esophagus had been closed off following an accidental injury and it was thus necessary for him to take food through an opening in his stomach. This made it possible to observe circulatory changes in the stomach and also to collect samples of its contents. Under a fear-producing condition, a "decided pallor" occurred in the subject's gastric mucosa, and there was also "a fall in the rate of acid production." When he was subjected to reproof which produced hostile reactions or resentment, the subject's stomach "became red and engorged and soon the folds were thick and turgid. Acid production accelerated sharply and vigorous contractions began." Although this is an unusual case, it suggests the possibility of a difference in stomach reactions associated with different emotions.

In another attempt to differentiate emotions physiologically, the subjects were connected with a wide variety of instruments like those already illustrated in Figure 7.5 (p. 183).<sup>28</sup> Fear was produced by electric shocks and certain activities of the experimenter which were calculated to produce alarm. Anger was provoked by derogatory comments made at the expense of the subjects.

Under fear-provoking circumstances the pulse rate was higher and there was more sweating than under conditions which produced anger. There were also certain differences in blood pressure, the details of which need not concern us here.

A laboratory experiment in which medical students were subjected to intense frustration yielded results which enabled the investigators to differentiate between anger directed toward the experimenter or situation, anger directed toward the self, and anxiety. Most of the data came from two stress-inducing situations. In one of these the subject was given various mental problems to do. The problems became progressively difficult and, as the subject began to miss the correct answers, he was the target of sarcastic remarks. This resembled in some respects an OSS procedure described in Chapter 9. The other stress-inducing situation involved a sonic-confuser. This is an instrument with earphones through which the person, while talking, heard his voice with a slight time delay. The delayed feedback was extremely frustrating and, among



**7.7 The Stomach and Emotion.** As described in the text, this man's stomach wall and contents became accessible to direct observation. The curve below shows changes in muscular activity of the stomach when something was said which made the subject ongrly. (From Sturgis Grant Productions, Inc., courtesy Smith, Kline & French Labs. and Cornell University.)

other things, produced marked stammering. Under these conditions the subject was given a story to read. He was then asked to read faster and at the same time to maintain accuracy. Whenever reading became slower, a slight electric shock was administered to indicate that the subject must speed up.

Before, during, and after the above forms of stress the investigators took tracings of heart activity and also the pulse rate and blood pressure. After a session was completed, the subject was interviewed to obtain his verbal reactions. It was from these that the *anger out*, *anger in*, and *anxiety* designations were derived. Most of the verbal reactions could be placed in one or another of these categories. Subsequent analysis of physiological data lent support to the view that experimental reports were correlated with physiological differences. Typical records are reproduced in Figure 7.8.

From the physiological reactions and the

known effects of adrenalin and nor-adrenalin (p. 241), it was possible to infer that *anger out* (with a low intensity of physiological response) is associated with the presence of nor-adrenalin in excessive amounts and that *anger in* and *anxiety* (with a high intensity of physiological response) are associated with the presence of excessive amounts of adrenalin. The few subjects who reported no anger had physiological reactions of low intensity like the anger-out group. Evidence from animal experiments is cited which suggests that nor-adrenalin is the resting secretion of the adrenal medulla and that adrenalin is secreted only when an emergency reaction is elicited. It appears, therefore, that the subjects who were angry at the external situation did not react in an emergency manner whereas those who became angry with themselves, and those who became anxious, did react as if they were in an emergency.<sup>29</sup>

In the above experiments, as in efforts to

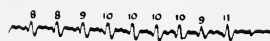
differentiate emotion from nonemotion, the physiological records alone did not tell the whole story. These had to be interpreted in terms of the situations which produced them and also the verbal reports of the subjects.

It remains to be seen whether research on the physiological concomitants of feeling and emotion will come to have diagnostic value independent of verbal reports, overt behavior, and information about the stimulating circumstances.

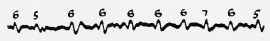
## EMOTION AS A FUNCTION OF THE WHOLE ORGANISM

The emotionally aroused organism is aroused all over. There is an overall interaction of receptors, muscles, internal organs, and nervous mechanisms, with resulting changes in blood chemistry, in brain waves, and in the physiological reactions already considered. All of the mechanisms involved are also activated

### ANGER OUT

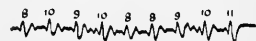


PRE-STRESS	
Systolic B.P.	136
Diastolic B.P.	56
Pulse	77
IJ	9.4
IJ x p	723.8

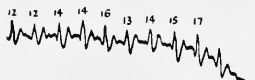


POST-STRESS	
Systolic B.P.	158
Diastolic B.P.	66
Pulse	67
IJ	5.9
IJ x p	395.3

### ANGER IN



PRE-STRESS	
Systolic B.P.	124
Diastolic B.P.	84
Pulse	76
IJ	9.3
IJ x p	706.8

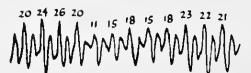


POST-STRESS	
Systolic B.P.	158
Diastolic B.P.	80
Pulse	86
IJ	15.7
IJ x p	1350.2

### ANXIETY



PRE-STRESS	
Systolic B.P.	136
Diastolic B.P.	56
Pulse	68
IJ	12.0
IJ x p	816.0



POST-STRESS	
Systolic B.P.	184
Diastolic B.P.	46
Pulse	118
IJ	19.6
IJ x p	2722.8

7.8 Differentiation of Anxiety and Two Directions of Anger. These are ballisto-cardiograph tracings typical of those which differentiate anger out, anger in, and anxiety. The systolic and diastolic blood pressure readings were taken with a sphygmomanometer (see Figure 7.5). I J refers to the mean height of the tracing. P refers to pulse. (From Funkenstein, D. H., S. H. King, and M. E. Drolette, *Mastery of Stress*. Harvard University Press, 1957, p. 40.)

under nonemotional conditions, but we shall see that certain ones are activated more intensely, differently, or in a different relation to others when we become emotionally aroused.

It had long been held that one has an emotional experience and that this in turn produces the bodily changes associated with it. The James-Lange theory of emotion<sup>30</sup> claimed that exactly the reverse is true. It argued that one first has the bodily changes and that emotional experience is *the feeling of these changes* as they occur. This theory was followed by another (the Bard-Cannon theory) which claimed that *both* the experiences and bodily

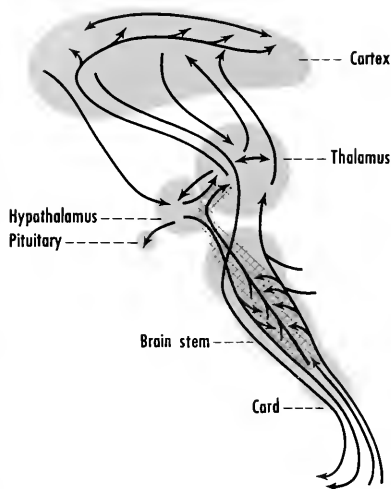
changes are set off simultaneously by a lower brain mechanism known as the *hypothalamus*.<sup>31</sup> These theories stimulated research on various aspects of emotion. Although this research failed to settle all of the issues involved, it did greatly extend our knowledge of underlying physiological mechanisms. Some of these are schematically represented in Figure 7.9.

### The receptors

First of all, consider the receptors. We have these in almost every part of the body. External receptors in the eyes, in the ears, and in our skin are necessarily involved in making us aware of our surroundings. Any emotion-provoking situation first activates such receptors. Receptors in our muscles are activated whenever we move. Thus running, struggling, trembling and other overt responses associated with emotion activate these receptors. There are also receptors in our internal organs. In the abdominal region are organs known as the *viscera*. These include the stomach and intestines. The feeling of "butterflies in the stomach," of nausea, and so forth, depends upon impulses originating in such visceral structures.

### The hypothalamus and cerebral cortex

Impulses from receptors travel into the central nervous system (spinal cord and brain). Some go up the spinal cord while others enter the brain directly. Before they get to the upper levels of the brain, however, nerve impulses must pass through lower brain centers known collectively as the *thalamus*. The *hypothalamus* is a group of nerve centers situated under



## 7.9 Schematic Representation of Principle Nervous Mechanisms Involved in Emotional Behavior.

This diagram represents basic structures and nerve impulses. Lines with arrows show direction of impulses. Some of these enter the spinal cord (lower right in diagram) and ascend to the *thalamus*. This is a switchboard mechanism which relays some of them to the *hypothalamus* and others to the *cerebral cortex*. Note interconnections between the *thalamus* and *hypothalamus* and between the *hypothalamus* and the *pituitary gland*. Follow the right-hand ascending path and note that such paths give off collaterals which enter a cross-hatched area, shown as running from the lower brain stem to the *hypothalamus* and *thalamus*. This represents an important mass of cells known collectively as the *reticular formation*. While nerve impulses are passing directly to the *thalamus* and via it to the *cerebral cortex*, others, through collaterals such as those illustrated activate the *reticular formation*. This discharges diffusely and impulses ascending from it to the *cerebral cortex* have an alerting function — the sleeping organism wakes up, the drowsy or passive one becomes suddenly alert. For this reason the *reticular formation* is often referred to as an alerting mechanism. This diagram also shows nerve impulses coming from the *cerebral cortex* to the *thalamus* and *hypothalamus*. The significance of these for emotion is discussed in the text. (Diagram modified from D. B. Lindsay.)

the thalamus. The hypothalamus first came into prominence with respect to emotion when neurologists observed that injuring it, accidentally in human beings and experimentally in animals, produces loss of emotionality—or apathy.<sup>32</sup>

The hypothalamus is involved in emotion in three ways. (1) Impulses from the receptors pass through or adjacent to it on their way to the cerebral cortex. This is true of impulses from the muscles and viscera as well as those from external sense organs. (2) Impulses come into the hypothalamus from the cerebral cortex above. These could be initiated when, for example, we have some emotion-provoking memory or thought. (3) Impulses are sent from the hypothalamus to the viscera and muscles. These are motor impulses. They therefore activate the structures with which they connect. The adrenal gland, for example, is stimulated to secrete adrenalin. Receptors in many of the reacting structures are activated in turn, and sensory impulses are fed back into the brain.

We have seen that one theory gives a key position to the hypothalamus. It assumes that when stimuli are emotion-provoking, the hypothalamus is activated by the incoming impulses. This in turn relays such impulses to the cerebral cortex. These, according to the theory, arouse feelings. Simultaneously the hypothalamus sends impulses to our viscera (giving us “butterflies” or nausea) and to our skeletal muscles (making us tremble, run, or go through facial expressions of emotion).

Nobody has yet shown that the hypothalamus activates full emotional experience or behavior. There is, however, clear evidence that it contains a group of nerve cells which activate overt expressions resembling those which occur in emotion. When these cells are electrically stimulated in a cat, for example, the animal retracts its ears, crouches, growls, raises its back, lashes its tail, and shows other reactions resembling those which occur in emotion. One investigator has found such reactions “stereotyped,” “stimulus-bound,” and therefore suggestive more of reflexes than of true emotional behavior. He thus designates them as “pseudo-affective,” or “sham emotions.”<sup>33</sup> Another investigator finds reactions which do resemble true emotion. His



**7.10 Electrically Stimulated Emotional Expression.** Note the permanently implanted electrodes in the head. The cat not only exhibited expressions simulating rage, but it also attacked the investigator. This sort of reaction occurred only when the electrodes entered a restricted region of the hypothalamus. Courtesy Dr. W. R. Hess, *Hypothalamus und Thalamus*, Georg Thieme Verlag, Stuttgart, 1956.

subjects, one of which is shown in Figure 7.10, exhibited expressions of rage, and also attacked him.<sup>34</sup> Others have shown that electrical stimulation in a particular region of the hypothalamus motivates avoidance learning, thus suggesting the presence of a “pain center.”<sup>35</sup> Electrical stimulation in a nearby region is positively motivating; so much so, in fact, that the existence of a “pleasure center” is suggested.<sup>36</sup> Thus there are several reasons for believing that the hypothalamus and related brain-stem structures are implicated in emotional behavior. The reticular system, whose alerting functions were mentioned in the legend of Figure 7.9, is also involved.

Although the hypothalamus is implicated in the neural control of emotional behavior, the cerebral cortex is also important. It may, at times, be of still greater importance than the hypothalamus. In this connection, consider these facts. Naturally aroused emotional behavior is not turned on or off like the reactions produced by electrical stimulation. The organism shows persistent motivated behavior. It does something about the situation in which it finds itself. A human being, for example, may do any of a number of things when emotionally aroused—he may swear, plead, pray, hide, run away, attack, or bluff his way out of a situation. Even after the emergency has

ended, he may continue to be emotionally aroused. He may have prolonged anxiety, he may brood, and, if he knows or suspects that certain persons are responsible for his predicament, he may plan a campaign of retaliation. These are higher-level activities, neurologically considered, and they show that the cerebral cortex plays a very important role in human emotion over and beyond that played by the hypothalamus and other mechanisms of the brain stem.

### The autonomic nervous system

Physiological changes in emotion — sweating, more rapid heart beat, and so on — are controlled through the *autonomic nervous system*. This is so whether the initiating impulses come from the cerebral cortex, the hypothalamus, or other structures of the brain stem. Those initiated at the cortical level, as when we think of something that makes us angry or afraid, are transmitted to the hypothalamus and through it to the autonomic nervous system.

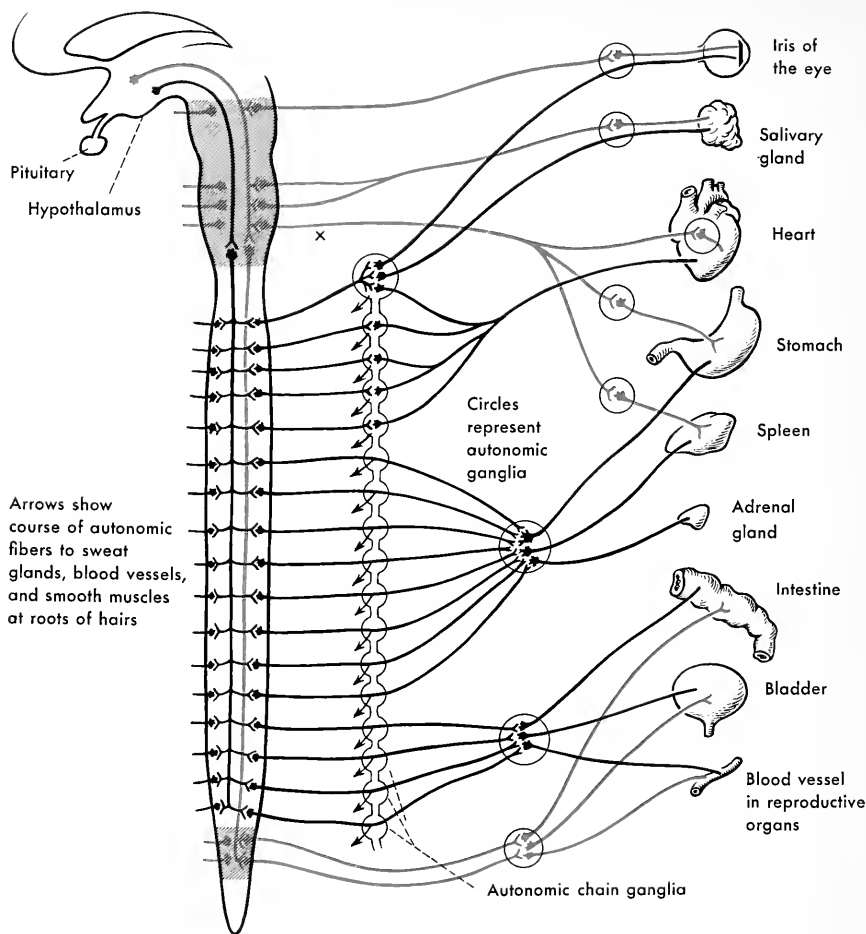
The autonomic system has a purely motor function. As shown in Figure 7.11, there are two main branches, the *sympathetic* and the *parasympathetic*. These systems work in opposition. If one activates (accelerates) an organ, the other checks (inhibits) it. Although both branches are involved in emotion, the sympathetic plays the predominant role. It accelerates the functions of some organs and inhibits the functions of others. For example, the sympathetic connection with the heart accelerates its activity; the parasympathetic connection checks it. The activities of the stomach, on the other hand, are checked by the sympathetic system and accelerated by the parasympathetic. Secretions of the adrenal gland are accelerated by the sympathetic and are under no known parasympathetic control. An emotionally aroused individual's heart pounds, his stomach contractions and gastric secretions are checked, and his secretion of adrenalin is accelerated — all because his sympathetic nervous system has assumed control.

With this survey of the various mechanisms involved in emotional activation, we can perhaps appreciate why emotion is as complex as it is. We can perhaps also appreciate why it

is difficult to differentiate between emotional and nonemotional states, why one emotion cannot be distinguished from another in terms of isolated physiological changes alone, and why psychologists do not as yet have a satisfactory theory relating bodily changes and affective experiences.

The mechanisms involved in emotion are functioning continually and the change from nonemotional to emotional states is often represented, physiologically, by no more than a shift in relative levels of activation. This fact is well illustrated by the following quotation, which begins with reference to a sleeping man:

His cerebral cortex is relatively inactive, showing only slight bursts of electrical activity on an electroencephalograph. The muscles are relaxed and send few return impulses to the central nervous system. The sympathetic or emergency division of the autonomic nervous system is inactive. . . . Now let the alarm clock ring. . . . Gross muscular responses occur and feed impulses back into the central nervous system. There is also autonomic discharge and some secretion of adrenalin, a "stimulant." The resulting changes in smooth muscle also feed back impulses. . . . A very important terminus is the hypothalamus, which amplifies these return impulses and activates the cortex. The electroencephalograph shows that the cerebral cortex is functioning at a higher level. [A] state of alert attention [exists] in which there is excellent discrimination among stimuli and appropriate responses. . . . But the level of activation is still far from its upper limit. Suppose that someone has taken a book our subject needs in his work. He becomes a bit angry, i.e., the level of muscular activity goes higher, there is more autonomic activity, and his hypothalamus feeds more impulses into the cortex. [Upon further provocation] he may go into a strong rage. Here the activation is very high, with resulting violent behavior. But the behavior is no longer nicely adjusted to stimuli; it is "blind" and uncoordinated. The increased feedback and chemical changes have so stimulated the hypothalamus that it largely breaks loose from cortical control. He responds almost as if he had no cerebral cortex, no previous learning about office routine or polite behavior.<sup>27</sup>



**7.11 A Schematic Representation of the Autonomic Nervous System.** Same typical relations between the visceral and other internal organs and the two major divisions of the autonomic nervous system, from various sources. Connections with the sympathetic system are represented in black; those with the parasympathetic in blue. Note that the upper (cranial) parasympathetic connections come from nerves in the head (cranial nerves). The most important of these, from the standpoint of emotion, is nerve X (the Vagus). While most of the internal organs have dual connections with the autonomic system, an apparent exception is the adrenal gland, the only known autonomic connections of which are with the sympathetic division. This division accelerates adrenal functions. It also accelerates the functions of certain other organs, like the heart. The functions of these organs are normally held in check by the parasympathetic. On the other hand, the functions of the stomach and certain other organs are accelerated by the parasympathetic and retarded by the sympathetic.

## EMOTIONAL DEVELOPMENT

Although it is possible to recognize various emotions in older children and adults, these are not evident at birth. Initially, as far as one can tell, there is merely excitement. Emotions develop gradually. It will soon become apparent that certain aspects of this emotional development depend upon the maturation of neuromuscular mechanisms. Other aspects are clearly learned.

Much of an infant's emotional activation is related to physiological needs, like the need for nourishment, to avoid injury, to keep warm, and to be active. Indeed, the infant's emotional reactions signal the presence of such needs. When its needs are satisfied, it is quiescent.

As discernible emotions appear, these supplement the motivation already present. The newly emerged emotional expressions are used to control others. Some emotions, like fear, anger, and affection motivate the individual himself.

An early investigation of emotional behavior in infants suggested that three emotions are present at birth; namely, *fear*, *rage*, and *love*.<sup>35</sup> More recent investigations, however, have failed to verify this suggestion. They have shown that

any form of sudden stimulation such as dropping, loud noises, restraint, pain, or a rush of air on the face, produces in the young infant aimless activity of most of the musculature, accompanied by crying. The stimuli must be sufficiently strong, however, to produce a reaction. When an infant below four or five days of age is dropped one or two feet, it frequently shows no perceptible response, except for vague movements of the arms and legs. The younger the infant the stronger must be the stimulus. This is also true for so-called "pleasurable" stimuli, such as stroking or petting, to which many newborn infants show no reaction.<sup>39</sup>

One investigator found only "mass activity."<sup>40</sup> Another found that any of four stimulating conditions produced "any and all responses."<sup>41</sup> Still another found only "excitement."<sup>42</sup>

The original investigators were apparently labeling the behavior fear, rage, and love in

terms of how *they* would react if stimulated as the babies were stimulated. Knowing that sudden loss of support would produce fear in themselves, they designated as fear the behavior elicited by loss of support. Moreover, they failed to observe or take into consideration such differences in reaction as were apparent to later observers.

Psychologists must always be on guard against "reading into" behavior something that is not there. In an experiment to determine how much graduate students in psychology, nurses, and medical students agree concerning emotional reactions of newborn infants, it was found that significant agreement was present only when the stimulating circumstances were known to the observers, and they were thus able to "read" their own reactions into the situation.

In the experiment here referred to, the emotional reactions elicited by hunger, dropping, a loud noise, pin-prick, and several other stimuli were presented in some instances on a motion-picture screen and in other instances directly, by having the judges look at the baby after a screen had been removed. In the first series of observations, stimulating circumstances were not known to the observers. Here there was little or no agreement concerning the emotion exhibited. For example, forty-two medical students who observed the reactions to dropping directly, but without knowing that the baby had been dropped, gave eight different designations, with *awakened* (11) *colic* (11), and *anger* (7) the most frequent. Only two said that the behavior was *fear*. Thirty-two graduate students in psychology who saw films of reactions aroused by dropping, but did not know that dropping had occurred, also gave widely scattered designations. The most frequent in this instance were *anger* (14), *hunger* (6) and *fear* (5). There was similar lack of agreement concerning behavior aroused by other stimuli. It is apparent that an individual is not likely to label the behavior as others label it when he does not know the stimulus which caused it. When the same graduate and medical students saw the stimulus as well as the behavior, they were in much closer agreement than when they witnessed the behavior alone. For example, 27 out of 41 said that dropping produced fear and 24 out of 39 that restraint produced rage.<sup>43</sup>

It is apparent, therefore, that the emotional behavior of the newborn fails to show clear-cut patterns to which definite emotional labels such as fear, rage, and love can be attached.

### Growth of emotional behavior in children

Although the newborn child shows only general excitement when stimulated by situations which arouse emotion in older children and adults, other emotional reactions are soon apparent. Psychologists do not agree on the labels to be attached to manifestations of emotion at particular age levels, but they agree that, as the child grows older, an increasing number of emotions becomes apparent.

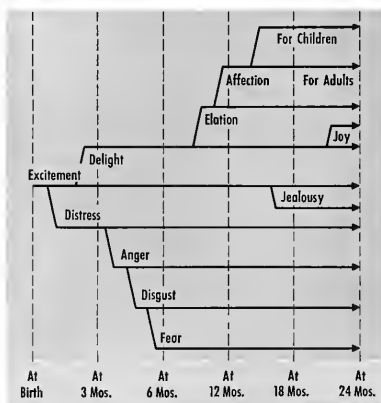
The diagram shown in Figure 7.12 illustrates one of the several classifications of emotional behavior in early childhood. It is based upon observations of a large number of babies in a foundling home, who ranged in age from newborn to two years.<sup>44</sup> In newborn infants, the investigator could discern only *general excitement*. But in the three-month-old child *distress* and *delight*, as well as general excitement, could be distinguished. Within the next three months, *distress* was differentiated so

that *fear*, *disgust*, and *anger* were also apparent. At about twelve months, *delight* had differentiated so that *elation* and *affection* were added to the repertoire of emotions. *Jealousy* and *affection for children*, distinguished from *affection for adults*, appeared between the twelfth and eighteenth months. Between the eighteenth and twenty-fourth months, *delight* was differentiated so that *joy* was also evident.

One should not, of course, accept as gospel the particular labels and age levels indicated in the diagram. We should look upon it rather as one psychologist's attempt to represent emotional development in children. The above discussion of early investigations of infant emotion should warn us that even an experienced psychologist may "read into" the behavior of infants more than is actually present, and that different observers may assign different labels to the same reactions. The classification is presented here merely to illustrate the fact that one who perceives only general excitement in the newborn discerns an increasing variety of emotions as the child grows.

The possibility of differentiating emotions at advancing age levels is further illustrated in Figure 7.13. Nobody would judge A to be happy, but is he hurt, angry or afraid? Without a knowledge of the cause, one cannot say. The two-year-old in B exhibits a clearer pattern of emotion. Anger, resentment or disappointment appears to be present.<sup>45</sup>

**7.12 Approximate Ages of Differentiation of Emotions in Early Childhood.** (Adapted by Dashiell from Bridges, K. M. B., 42.)



### Maturation and learning in emotional development

Both maturation and learning play important roles in emotional development. In some instances it is possible to recognize their respective influences, but in others they are inextricably related.

**Maturation.** As the infant grows, even when no opportunity has been presented for learning them, such emotional responses as crying, weeping, (crying with tears), smiling, and laughing begin to appear. These emotional reactions appear at about the same age in all children, regardless of variations in stimulation provided by adults. They also occur where all opportunities to witness them in others have been removed.<sup>46</sup>





A



B

**7.13 Differentiation of Emotion at Different Age Levels.** One might have difficulty in judging the emotion expressed by the baby at the left, but the older child almost certainly is expressing anger, resentment, or disappointment. (Photos by Roy Gain and Spenser, from *Black Star*.)

Further evidence that maturation plays a large role in emotional development comes from observations of facial expressions in the deaf-blind (Figure 7.14). Those born both deaf and blind would have very little, if any, opportunity to acquire emotional behavior by imitating others. They certainly could not hear the sound of laughter and observe how it is produced, they could not see individuals clench their fists in rage, and they could not see the various facial expressions of emotion. The only way in which such expressions could be known to them would have been through touch. But even when they have been given no tactual training, they exhibit emotional reactions which have much in common with those of normal people. Take, for example, these observations of emotional behavior in a ten-year-old girl who was blind and deaf from birth, who had not been able to learn to speak or to care for herself, and who had received no training in emotional expression.

A small doll was dropped down the child's dress, whereupon neck and shoulders tensed and the mouth half-opened. The sightless eyes opened to the fullest extent and the eyebrows were raised. The left hand at once began to grope for the toy. But the posture and the

facial expression were suggestive of what we should ordinarily interpret as startled attention. After several minutes of unsuccessful efforts to get the doll, which caught in the folds of her dress, she did not cry, but made slight whimpering sounds. . . . Suddenly, as if struck by a new idea, she renewed the attack, this time from a different angle. Her behavior took on the appearance of a struggle, determined in part by exasperation and mild rage. Her body writhed and twisted; the right hand impatiently beat the arm of the chair. . . . At the instant of success in extricating the doll, she threw herself back into the chair with feet drawn up under her. Both the hand containing the doll and the empty hand were raised in an attitude of delight, which was further attested by peals of laughter. . . . The exultant laughter faded to a smile of pleased satisfaction.<sup>47</sup>

*Learning.* The role of learning in emotional development is clearly evident when we consider the stereotyped gestural and facial expressions which are not common to all men, but which characterize a particular culture. An interesting comparison is provided by our own and Chinese expressions of the same emotions, or what are presumed to be the same



## 7.14 Emotional Expression in a Deaf-Blind Child.

The facial, and also vocal expressions of emotion in the deaf-blind have much in common with those of hearing and seeing children. This is true even when a child has been both deaf and blind since birth, hence prevented from ever hearing or seeing the expressions of others. (Photo courtesy of Perkins Institution for the Blind.)

emotions. Some emotional expressions are similar in us and in the Chinese, but others are very different. Surprise in us is made evident by raising the eyebrows and opening the eyes wide, but the Chinese usually express surprise by sticking out their tongues. Scratching ears and cheeks is a sign of embarrassment in us, but to the Chinese it means happiness. Clapping the hands is a sign of happiness in us, but of worry or disappointment in the Chinese.<sup>48</sup> These emotional expressions are superimposed upon inborn expressions like those of the deaf-blind child. They are acquired from observing similar expressions in others.

The role of learning is also evident when we consider how particular emotions are aroused by different objects and situations as we get older. Infants are usually not afraid of snakes, white rats, or mice (Figure 7.15). Fear of snakes, for example, usually begins to develop at about two or three years of age.<sup>49</sup> Maturation, in the sense of giving the older child a keener perception of the peculiarity of the snake's movements, may be involved. But fear of snakes as particular objects comes from hearing stories about snakes, observing how older children and adults react to snakes, and perhaps by transfer to snakes of a fear

of the strange or the unusual, acquired in other circumstances. Some older children and adults never develop a fear of snakes, of white rats, of mice, or of other animals and objects which arouse fear in others.

Studies of children's fears and those of their parents have shown that if the parent is afraid of the dark, of lightning, of snakes, or of particular individuals, the child will very likely have the same fears.<sup>50</sup>

A classical experimental study of the acquisition of fear in a child is the case of Albert.

Albert, a normal child of nine months, exhibited fear reactions to a loud noise unexpectedly presented, but had no fear of white rats. Fear of rats was acquired under the following circumstances: When the rat was first placed before him, Albert reached for it, showing no signs of fear. Just then a loud noise was made behind his head by striking an iron bar. Albert started and fell forward on his face. . . . The rat and the noise were again presented, the noise just after the rat. This time Albert responded as before except that a whimper was added. After five further presentations of the rat and noise, separated from the other two trials by a week, Albert was afraid of the rat alone. Not only this, but he

was now afraid of objects closely resembling the rat in certain respects. For example, the same fear reaction (Figure 7.16) was aroused by a rabbit and a white beard. Wooden blocks and other objects bearing no similarity to the rat did not produce the response. The fear reaction to a rat, rabbit, dog, coat, and cotton was evident a month later, but it had decreased in intensity.<sup>51</sup>

It is evident that, by associating some stimulus which produces emotion with a stimulus which does not produce it, we may give emotion-provoking potency to the previously neutral stimulus and to stimuli similar to it. The technique here is that of conditioning, discussed more fully in Chapter 10.

When a newborn infant is emotionally aroused, about all he can do is cry and thrash his limbs about. As he grows older, however, his emotional behavior shows a much wider range, some of it attributable to maturation and some to learning. Thus, the emotionally aroused one-year-old can stiffen his body, hold out his arms, throw things, call out, and cling to an object or person, as well as cry and thrash his limbs. As he gets older, language responses play an increasing role in his emotional behavior. He makes demands, scolds, pleads, swears, talks about others, and makes his feelings felt in many other ways.<sup>52</sup> Most of these acquisitions are not emotional in themselves. They are merely utilized in emotional situations as well as nonemotional ones.

Other acquisitions give the child a greater ability to cope with his environment, thus reducing frustration and other emotion-provoking situations. He learns to help himself by getting out of bed alone, to satisfy his hunger by going to the pantry shelf, and to protect himself by fighting the neighborhood bully.

#### **SITUATIONAL ASPECTS OF EMOTIONAL DEVELOPMENT**

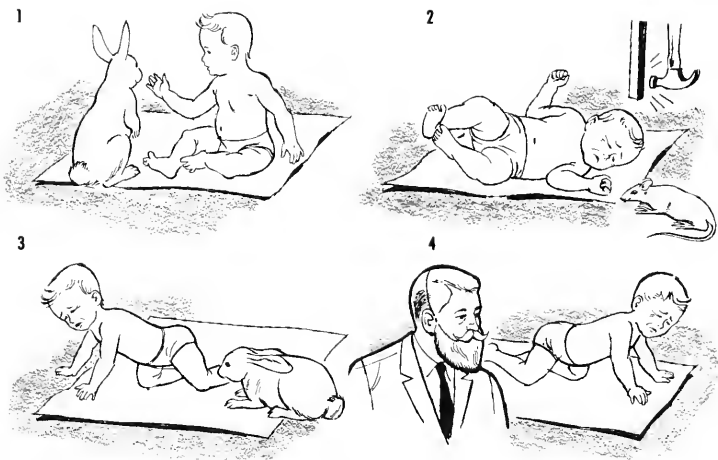
At birth, relatively few situations arouse emotional behavior, or what we infer to be excitement. Such stimuli as a loud noise, a sudden loss of support, and stroking of the erogenous zones are often emotion-provoking to the newborn, but they do not, as we have seen, arouse differentiable reaction patterns. Marked restriction of activity, as by holding

the head between the hands, is also prone to arouse excited behavior. Emotional reactions are frequently elicited by hunger, colic, having the nose cleaned, and other bodily discomforts. Crying is the most specific response to such discomforts, but it is usually accompanied by thrashing about of legs and arms. Any abrupt change in the situation, such as the turning on of a light, a sudden noise, or the appearance of a person, will usually produce a startle reaction.

During early development, maturation and learning give potency to many stimuli which failed to elicit emotional reactions at birth. Following the conditioning principles already mentioned, fears of particular objects, persons and situations are likely to develop. Grotesque masks do not frighten an infant in its first months, but they do an older infant, until he becomes accustomed to them.<sup>53</sup> Scolding and frowning at a baby of three months is likely to elicit laughter, if anything at all, but frowning at or scolding a child of six or seven months is more than likely to arouse behavior suggesting anxiety or astonishment.<sup>54</sup>

**7.15 Many Fears Are Learned.** Children do not fear mice, rats, and other animals unless they are negatively conditioned to them. (Esther Bubley.)





**7.16 Conditioning Fear in an Infant.** Before conditioning (1) the child makes positive (approach) reactions to the rabbit. A loud noise (2) produces startle and apparently fear. Paired association of a white rat and noise produces an avoidance response not only to the rat but also (3) to the rabbit. Finally (4) furry objects of various kinds, which were ineffective earlier, also elicit avoidance reactions. (After Watson, from G. G. Thompson, *Child Psychology*. Houghton Mifflin, 1952, p. 144.)

### FEAR AND ANXIETY

These emotions are closely related. One usually has had experiences of fear before he experiences anxiety. This will be evident from experiments to be described shortly. We have seen, too, that some subjects respond to a stressful situation with fear (directed outwardly or inwardly) while others respond to the same situation with anxiety (p. 185).

#### Fear

In one investigation of the situations which arouse fear in children of various age levels, observations by parents were supplemented by interviews with children. The parents were especially trained to make and record their observations. An idea of the nature of the findings from this study may be gathered from Figure 7.17, even though only four of the ten classifications of fear-provoking situa-

tions are included. It is quite apparent that animals increase and that noises and strange things decrease in emotional significance as the child grows older. Threats to life and limb, on the other hand, are completely ineffective as instigators of fear during the first two years. They increase, then decrease in potency as the child grows older.<sup>55</sup>

As the individual grows beyond childhood, real fear, at least in our society, is a relatively infrequent occurrence, the reason being that we can cope with most situations that arise. Fear-provoking incidents — such as being accosted by a stranger in a dark alley, having (or narrowly escaping) an automobile accident, being on a plane with its engine on fire or with landing gear that fails to function, going into action under fire — are seldom if ever experienced by most people. But this does not mean that fear is absent from their lives. As we said earlier, human beings have

the capacity to anticipate all sorts of dangers and to worry about them. We then speak of *anxiety* rather than fear, although anxiety takes its origin from the latter.

## Anxiety

Psychologists and psychiatrists use the concept of *anxiety* a great deal. Synonymous terms are *worry*, *apprehension*, *dread*, and *uneasiness*. Although all anxiety is related to fear, its meaning differs somewhat depending upon the context in which the concept is used. Animal psychologists who want to make their subject "anxious" give it strong electric shocks in a certain situation. It attempts to escape, it squeals, it defecates, it urinates and in other ways justifies the inference that it is afraid. When placed in the same situation later, but without electric shock, the animal again appears to be afraid. Now, since there is in reality nothing to fear, it is said to show "anxiety." If it persists in attempts to escape,

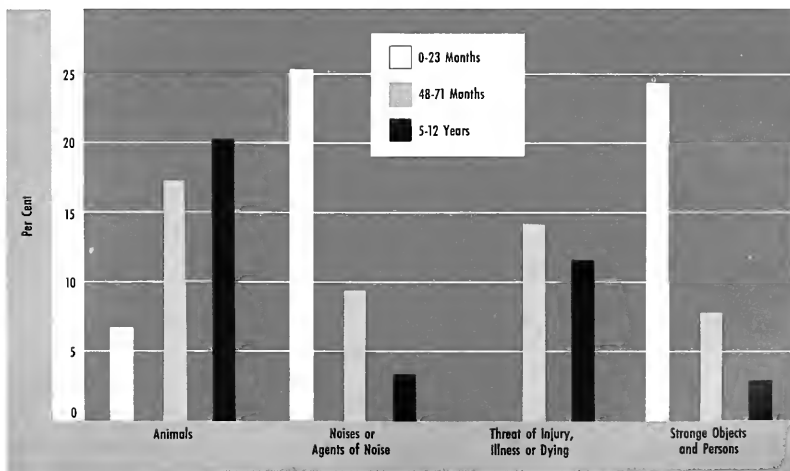
the investigator says that it has acquired "a drive of anxiety."<sup>56</sup>

Many neurotic people who have perhaps never actually suffered pain in the situations concerned are also said to be anxious. See, for example, the discussion of anxiety states and phobias in Chapters 6 and 9. Albert's fear of a rabbit after fear-provoking experiences with a white rat (p. 194) could be regarded as anxiety. In a somewhat comparable manner, the child who has been inoculated becomes anxious when he sees the preparations for another shot, or even when he sees or hears the doctor approaching. The child who has had painful experiences in the dentist's chair likewise becomes anxious, even at any mention of going to the dentist.

All such uses of the term *anxiety* have some reference to fear. What the individual is anxious about is something that has happened which he fears may happen again.

But human beings also worry about things that have never happened to them. As we

**7.17** Per Cent of Each Group Fearful in Four Emotion-Producing Situations. (Drawn from data in Jersild, A. T., F. V. Markey, and C. L. Jersild, 55.)





**7.18 Studying Anxiety by a Projective Technique.** The child is asked to indicate which of the two expressions applies. He is asked, "What kind of face do you suppose this child will have, a happy face or a sad face? He (she) is using the bathroom." (From Darkey M., and W. Amen, 57.)

said earlier, they anticipate what *could* happen — like losing their loved ones, being without a job, becoming ill, and so on. The super-ego is also a source of worry, for many have guilt feelings about things they have done that they know they should not have done. They often fear that they *may* do something reprehensible.

Psychologists have used projective tests to reveal the nature and extent of children's anxieties. An item from one anxiety test is reproduced in Figure 7.18. When the entire test was administered to nursery school children, the number of items eliciting anxiety reactions ranged from 7 to 86 per cent, with

a mean of 38 per cent.<sup>57</sup> Children's anxieties often concern such things as losing affection and security. The child may worry about being abandoned, the possible death of its mother or father, and, at later age levels, of losing friends, having a bad report card, and many other things. Some of the earlier anxieties are tempered where the child makes friends outside of the home. The following anecdote<sup>58</sup> illustrates this.

A grandmother was recently reminded of the significance of child friends when her daughter and son-in-law stopped by her house to leave their three drowsy and half-awake children while their mother went to the hospital to have her fourth child. Though the arrangements had been explained to the children in advance and although their grandmother and grandfather were loved figures, the middle-of-the-night change in the children's circumstances apparently called for some reappraisal of the sources of their security. As the grandmother tucked in the six-year-old, the child said thoughtfully, "Well, I have a friend now in the first grade," and with that consoling reflection, fell asleep.

Projective tests are used at the adult level as indicators of anxiety. There are also "worry inventories" and "anxiety scales." Basically, most of these are checklists of the things about which adults are commonly anxious. The *Taylor Scale of Manifest Anxiety* is currently the most widely used test to assess anxiety in adults. The subject answers *True*, *False*, or *Cannot say* to items like the following:

- I am unusually self-conscious
- I am happy most of the time
- I am entirely self-confident
- It makes me nervous to have to wait
- I am often afraid that I am going to blush

There are 50 such items scored in terms of the number answered in the anxiety direction — for instance, *true* to the first and the last two of the above examples and *false* to the others. In a group of nearly 2000 college students, the range of anxiety scores was from 1 to 46, with the median at around 13. Among 103 psychiatric patients, on the other hand, the range was similar, but the median was

approximately 34.<sup>59</sup> This scale has been used in several investigations to select groups of subjects with high and with low anxiety.<sup>60</sup> The aim has been to see how anxiety influences learning and other processes.

In another type of investigation, students kept a diary for one week and, from this, noted the things conducive to anxiety. Among a group of college girls, anxiety centered mainly around school work (40 per cent of all instances), anticipated loss of prestige (30 per cent), and illness and physical danger (17 per cent).<sup>61</sup>

### ANGER AND AGGRESSION

Reactions interpreted as "anger" or "rage" may be produced in cats by electrically stimulating a group of nerve cells in the hypothalamus. A cat thus activated was shown in Figure 7.10, p. 188. Somewhat comparable reactions may be obtained when the cat's cerebral cortex is removed, with the hypothalamus left intact, or when a brain-stem structure which connects the hypothalamus and the cortex is destroyed. In the latter event, we have "a bad-tempered animal with long-lasting rage."<sup>62</sup> Thus, in the normal cat, there appears to be "a balance between regions which excite anger and those which inhibit or repress it."<sup>63</sup> In instances of "blind rage" in human beings, where they seem to "take leave of their reason" and commit unseemly aggressions against others, there must be some slip-up in cerebral control. The writer knew a man who became so angry when his car failed to start that he cursed at it and kicked it again and again. Such unreasonable behavior in an otherwise intelligent person could be produced chemically, as when alcohol makes an individual less inhibited by inactivating cells in his cerebral cortex, or it could have some other basis. It has been claimed, for example, that a temporary shutting off or reduction of the blood supply to certain areas of the cortex might be responsible for the tendency of many old people to show "irrational changes in behavior, sometimes becoming more fearful and sometimes unreasonably belligerent."<sup>64</sup>

Although much is yet to be learned about the physiological bases of anger, and why it may lead people to act in such an unreasonable manner as it often does, we do know

that the precipitating factor is usually frustration or anticipated frustration. Restriction of activity is a form of frustration which often arouses anger in human beings.

Anger in children is most often aroused by such frustrating situations as having something taken away, being pushed around by another child, or having ongoing activities interrupted, perhaps as in Figure 7.19. Even in college students frustrations of everyday life which arouse anger are common. In the group mentioned earlier on this page, anger was most frequently aroused by interference with their plans (52 per cent of all instances of anger).<sup>65</sup> In another study, involving college men and women, thwarting of self-assertion (that is to say, the opposition of others to their plans) accounted for most of the outbursts which occurred during one week of self-observation.<sup>66</sup> What other people do and say is, as we said earlier, an important basis of annoyance, which can be considered a mild form of anger.

**7.19 Frustration and Anger.** This child, 20 months old, was in a doll parade when her anguishing activity was restricted as illustrated. (Caurtesy United Press International.)



## SMILING, LAUGHTER, AND HUMOR

Smiling in response to a smile does not usually occur before the child is about two months old. Laughter appears about a month later.<sup>67</sup> Such situations as peek-a-boo games, tickling, and word play are common laugh-provokers in young children. Later there is ability to appreciate things that older persons might regard as humorous — like seeing someone fall, become the victim of a practical joke, or act in an incongruous manner. Appreciation of cartoons, verbal jokes, and the humorous aspects of such stories as *Penrod* and *Tom Sawyer* develop during the early school years.

The essential conditions for laughter, or humor, have intrigued philosophers for centuries. There are various theories as to what constitutes the humorous, none of which seems likely to receive general acceptance, but all of which perhaps have an element of truth. Some of these alleged causes of humor are: "An error or deformity which is not painful or destructive" (Aristotle), "a strained expression suddenly being reduced to nothing" (Kant), "an expression of incongruity" (Schoopenhauer), a feeling of "sudden glory" (Hobbes).<sup>68</sup> Freud also had a theory which, simply stated, says that

humor gives pleasure by permitting the momentary gratification of some hidden and forbidden wish and at the same time reducing the anxiety that normally inhibits the fulfillment of the wish. By making light of the forbidden impulse, treating it as trivial or universal, a joke or cartoon releases inner tension. The sudden release of tension [cf. Kant, above] comes as a pleasant surprise, while the unconscious source of the individual's tension is so disguised in the joke that it is usually not disturbing.<sup>69</sup>

Psychologists have developed various tests designed to rate people for "sense of humor." One of these, part of a test of "social intelligence" describes various situations, each with four possible outcomes, and the subject indicates the most humorous of the four.<sup>70</sup> Thus:

"Johnny, if you eat more cake you'll burst."

(1) "Why, I've eaten this much before."  
(2) "No, I have a tough stomach." (3) "Then, I'll be able to take still more." (4) "Well, pass me some and get out of the way."

There are a large number of items, some more subtle than this, with one possibility in each rated as the most humorous.

Another device, known as the *Mirth Response Test*, utilizes twenty cartoons selected from the *New Yorker* and the *Saturday Evening Post*. A subject is shown the cartoons one at a time and his reactions are recorded. He is then asked to sort the cartoons into three piles — those he likes, those he is indifferent to, and those he dislikes. An interesting outcome of this research is not only that it reveals marked individual differences in mirth, but that it also, through the subject's remarks, tells a great deal about *why* he likes, dislikes, or is indifferent to what is supposed to be a humorous situation. One cartoon shows a man who

while watering his lawn with a garden hose turns to look at a pretty girl in shorts walking by and in doing so sprays his wife, who is sitting on the porch. Most men will laugh at this "accident" because it dramatizes in innocent form a common secret dissatisfaction and desire to philander. Women, understandably, tend to see nothing funny in this type of cartoon; too often they find themselves close to the role of the sprayed wife.<sup>71</sup>

Such an interpretation is in keeping with the Freudian concept of humor.

## HAPPINESS AND AFFECTION

Happiness in childhood is associated primarily with parental endearments and such things as playing and being read to. Later it is also associated with reading, hobbies, and engaging in various social activities, including games. A continually happy or unhappy child is rarely observed. It is also unusual to observe a continually happy or unhappy adult. In a study of happiness in college students, 33 of a group of 112 students reported that they were almost always happy and only three said that they were almost always unhappy. Forty-eight were more often



happy than unhappy. Of particular interest to us here, however, are the situational bases of happiness. The bases of happiness which rated highest were, in order of frequency, good health, joy of work, love, and a clear conscience.<sup>72</sup> In another study, graduate students in education rated joy in work as the major factor in happiness.<sup>73</sup> In still another study, students rated by themselves and associates as above average in happiness were also rated above average in competence and efficiency.<sup>74</sup>

The most primitive basis of affection is doubtless pleasure associated with stimulation of the erogenous zones, warmth of the mother's body, suckling at the breast, and being fondled and cuddled (see p. 149).

The stimuli for affection in older infants are many. The writer's boy had a toy rabbit, soft and woolly, which he took to bed with him for years and hugged and kissed like a person, even when it grew decrepit beyond description. This sort of thing happens in almost every family. The basis of such affection for objects and persons is not very readily traced. There is reason to suppose, however, that the original stimuli are such as the mother provides (Figure 7.20) and that other objects and persons become substitute stimuli for affection. As the child grows older, however, the stimuli which will arouse affection are limited by cultural influences like those mentioned in our discussion (pp. 156-157) of social and cultural factors in motiva-

tion. Sexual attraction of course becomes a potent factor when members of the opposite sex, and sometimes of the same sex, are concerned. Sexual factors probably play a minor role in maternal and paternal affection and in normal affection for members of the same sex.

Even in heterosexual love, as between normally adjusted husbands and wives, sex is no more than a contributing factor, although an important one. We quoted in an earlier discussion (p. 155) the statement that "man lives by bread alone — only when there is no bread." Under normal conditions of marriage in our society, sex, like eating, becomes subsidiary to other aspects. Human love, in addition to its sexual aspects, satisfies several motives, and perhaps somewhat different motives in different individuals. Some men want to be "mothered" by their wives, some women want husbands who will take a paternal attitude toward them — perhaps men who are like "daddy." Some feel pride in possession — in having made a "good catch." Affection between partners, even beyond the sexual attraction, may become very important. In any event, there is a great deal of "ego-identification."

Since the lover is very concerned with the happiness and growth of the [loved one] he will himself *feel* the pleasures and pains, the dangers to and happiness of his [loved one] *as if they were his own*. It is as if he had extended the "contact-surface" of his mechan-



**7.20** Affection Between Mother and Child. Children learn to have affection for others in such social situations as this. (Suzanne Szasz.)



**7.21 Jealousy.** Resentment of the baby (or of the amount of attention the baby gets) is evident in the older child's facial expression. (Patterson, from *Black Star*.)

isms for feeling and experiencing. He reacts emotionally to the events which affect his [loved one] as well as to the events which affect him personally.<sup>75</sup>

What we have been referring to is love "in our society," not love in general. There are good reasons for this distinction. In the first place, love is unknown among animals. With respect to them, we are justified only in speaking of sex. In the second place, romantic love is something relatively new in the history of mankind, and even today, foreign to some societies. The following is an excellent statement of these facts.<sup>76</sup>

One thing that is fairly clear is that "romantic love" is not an emotional pattern unique in nature and universally found throughout mankind. It is not inborn. History and anthropology suggest that what Americans know as "love" and conventionally hold to be the one essential to successful marriage — a view much insisted upon in motion pictures and in popular magazines — is a particular acquired integration of emotional segments traceable largely to the ideal of knightly chivalry formulated in the Middle Ages; for it is a pattern almost im-

possible to find in the behavior of men and women in Hebrew, Greek, Roman, Levantine, Chinese, and even in much of contemporary European society.

## JEALOUSY

Jealousy, as we saw earlier (p. 192) is a late-appearing emotion. It can only occur in social situations, hence it does not appear until a certain degree of social perception and participation has developed.

The most frequent cause of jealousy in young children is the arrival of a new child in the household. Parental attention to the newcomer, especially when it deprives the older child of accustomed attention and affection, may arouse reactions like those pictured in Figure 7.21. Sometimes the younger child is attacked, even seriously injured. Jealousy may also be expressed by ignoring the other child, denying that it exists, refusing to eat, bed-wetting, and various ways of getting attention.

Jealousy like the above is often preventable. It is motivated by anxiety. The older child feels "dethroned" by the newcomer and rejected by those who have formerly loved him.

One way in which such anxiety may be avoided is to prepare the child for the coming of a brother or sister. This preparation can be informative, and also such as to make the child feel that the newcomer will be an asset — someone to be proud of, to care for, and later to play with. When the baby arrives, the child can be allowed to help — in bathing it, powdering it, and so forth. Moreover, the parents can refrain from giving it all of their attention and affection. Under these circumstances, the older child will not feel that he is “left out” and there is less likelihood that jealousy will develop.

Jealousy also appears in many other situations where a threat to accustomed pleasures, to prestige, and to other forms of ego-involvement are present. Playmates become jealous when a friend forms new attachments. The child may become jealous of one parent's relations with the other. Freudian psychoanalysts<sup>77</sup> have stressed the so-called *Oedipus complex* (in which the boy becomes jealous of his father's relations with his mother) and the reverse of this, the *Electra complex* (wherein the girl becomes jealous of her mother's relations with her father).<sup>8</sup> These complexes are prevalent in our society, but by no means universal. There are often sexual implications in these and other forms of jealousy, as when a person is anxious for fear someone else will deprive him of his loved one.

In older children and adults, jealous behavior has many facets, although sulking and direct or verbal attacks are rather persistent at all ages.

## SYMPATHY

The most common stimulus for sympathy is seeing, hearing, or learning of someone else in distress. Identification is involved. This is “feeling oneself into” the other person. Why we feel sympathy for others has received considerable discussion. Some have regarded it as an essential aspect of gregariousness and as in-born. According to McDougall,<sup>78</sup>

<sup>8</sup> Freud took these terms over from Greek mythology. Oedipus killed his father and married his mother. Electra helped to kill her mother to avenge the death of her father.

sympathetic induction of emotion and feeling may be observed in children at an age at which they cannot be credited with understanding of the significance of the expressions that provoke their reactions. Perhaps the expression to which they respond earliest is the sound of the wailing of other children. A little later the sight of a smiling face, the expression of pleasure, provokes a smile. Later still fear, curiosity, and, I think, anger are communicated readily in this direct fashion from one child to another. Laughter is notoriously infectious all through life, and this, though not a truly instinctive expression, affords the most familiar example of sympathetic induction of an effective state. This immediate and unrestrained responsiveness to the emotional expressions of others is one of the great charms of childhood.

This statement implies that there is a more or less automatic response, as well as considerable ability to respond differentially, to variations in another's emotional expressions. It should be noted here, however, that the person in whom sympathetic response is aroused may be responding to the emotion-provoking situation rather than, or in addition to, the emotional expressions of another. One theory supposes that a person's sympathy is based upon how *he* has responded (or felt) in comparable situations. According to this theory, “the emotion aroused in the sympathizer is a part of his own system of emotional habits from past experience, evoked as a conditioned response to some element common to the original and the present situations.”<sup>79</sup> This is to say that a child who cries or feels sad when he sees another child in trouble is exhibiting the response which he has himself previously exhibited in comparable situations. This is a plausible explanation of many instances of sympathetic behavior, but it needs much amplification if it is to account for all of them. It seems but a first step. Take, for example, the following account of sympathetic behavior in preschool children. Only the first part — “sympathetic imitation” would be covered by either of the above theories.

Some children seem to be much more sympathetic than others — that is, they are moved or affected by another's distress. As a rule children make no attempt to express such sym-

pathy at first, they only stare or perhaps cry in sympathetic imitation. Later, when they are more socially adjusted, they express their feelings by trying to comfort the child in trouble. This may take the form of an affectionate embrace or an arm put gently around the distressed child. It may take the form of comforting words as "Don't cry, I'll ask my Mummy to get one for you," or it may take the form of simply asking "What are you crying

for?" or "Does it hurt?" in gentle, kindly tones.<sup>80</sup>

There seems little doubt but that, whatever the basis of sympathy, as an emotion, the sympathetic responses described above, and they are perhaps typical, are acquired from the social milieu. The child does what his parents and others have done for him and what he has observed people do for others in times of distress.

## Summary

The term *emotion* covers a wide range of behavior — behavior that is agitated and without definite orientation as well as behavior that is highly motivated and goal-directed. Milder forms and intensities of emotion provide a motivational background to much that we do. In emergency situations, largely through adrenal secretions, we have energy in excess of that normally present. The feeling aspect of emotion is sometimes definitely related to physiological activities (butterflies in stomach, pounding heart). Feelings (affective processes) such as pleasantness and unpleasantness (and related facial and other bodily expressions) have been studied. Freud stressed the "pleasure principle" as an aspect of motivation. However, such subjective aspects of emotion are difficult to investigate scientifically.

Laboratory research on emotion has dealt primarily with physiological concomitants of emotion-provoking situations and reported experiences. Such facts as the following have been revealed: Emotional activation is widespread, involving every part of the body. Some emotions can be differentiated from others in terms of stomach activity, electroencephalograms, heart activity, and blood pressure. Stronger emotional feeling produces more intense physiological reaction, including psychogalvanic response, than weaker emotional feeling. Anger directed outward can, on various physiological bases, be differentiated from anger directed inward and anxiety. In general, however, overt behavior and verbal reports, supplemented by knowledge of the stimulating circumstances, give us a surer differentiation

of emotion than that provided by records of physiological activity alone. The lie-detector usually measures blood pressure (with a sphygmomanometer), respiration (with a pneumograph) and sweat-gland activity, or psychogalvanic response (with a psychogalvanometer). Although useful in differentiating guilty from innocent suspects, lie-detectors are not fool-proof.

Structures known to be of especial importance in emotion are the receptors (without which we could not perceive a situation), the hypothalamus (which has much to do with emotional expression), the autonomic nervous system (the sympathetic division of which, under control of the hypothalamus, is most directly involved in producing the physiological changes associated with emotional activation), and the cerebral cortex (activities of which can set off emotional reactions, prolong and direct their expressions, and give rise to emotional experiences). All of these structures are integrally related in emotional behavior and experience. The reticular formation has also been considered to play a role in emotion. Two theories of emotion (James-Lange, Bard-Cannon) relate bodily and neural changes in emotion with emotional experiences, but neither has received general acceptance. It is probable that a completely adequate theory would have to include features of both theories.

The development of emotion in children has been studied intensively. At birth there is apparently only one emotional response; namely, general excitement. As an infant grows, its rep-

ertoire of emotions and specific emotional reactions becomes increasingly varied. During the first two years of life, one may discern the emergence of several new emotional expressions.

Occasions for emotional upset tend to decrease as the child learns to master his environment. Nevertheless, objects which previously aroused no emotional reactions often come to do so. Thus fear of snakes, of the dark, and of particular persons may develop.

The facial and postural aspects of emotion soon conform, more or less closely, to the expressions which characterize members of the child's own group. Some aspects of emotional expression are undoubtedly due to maturation. This is especially true of responses like weeping, laughing, and certain other relatively simple reflexes. These responses appear even when there have been no opportunities to learn them, as in the case of the congenitally blind and deaf.

Fear and anxiety are closely related and the latter is often the aftermath of fear-provoking experiences. Studies of college students as well as children show that anxiety is a very common experience in our society and that it centers around a wide variety of possible events—like loss of loved ones, loss of status, and illness.

Anxiety has been studied with projective tests as well as pencil-and-paper anxiety scales.

Anger and aggression are induced by frustrating situations. Experimental studies with animals have shown that disruption of certain connections between the cortex and the hypothalamus can produce something suggesting "blind rage."

Smiling first appears at the age of about two months, and laughter about a month later. There are several theories which purport to explain why certain situations provoke humor.

Happiness and affection begin in parent-child relations. Mature heterosexual love has many aspects besides the sexual. Romantic love is known only to human beings and, even among them, it is of fairly recent origin.

Jealousy is by its very nature a socially instigated emotion. It is in relation to this emotion that the Freudian Oedipus and Electra complexes are discussed. Sympathy is also a socially instigated emotion and it appears to involve identification with others in distress.

Further aspects of emotional adjustment are considered in the following chapter, in which we discuss compensatory and other reactions aroused by frustrating situations.

(References for this chapter are on page 551 of the Appendix.)

## Selected Readings

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# Frustration and Conflict



Barriers • Conflict • Severe frustration • Reacting realistically to frustration • Consequences of unresolved conflict • Compensatory reactions • Fantasy • Belittling and blaming others • Overcompensation • Projecting • Rationalizing • Regression • Repression • Reactions to experimentally produced conflict • Conflict, “will power,” and initiation of action • Summary

When we are hungry and dinner is long delayed, we experience displeasure. There is internal tension, irritability, and perhaps annoyance or anger directed toward the situation or persons responsible. When the dinner appears, our emotional tensions subside.

Such temporary delays are experienced by all of us and they are of little or no consequence. But some motives cannot be so easily satisfied. It takes years of study before we can graduate. It may take longer still to save enough money to establish our own home. We may have to mark time, as it were, by serving in the armed services — perhaps by going to war. But even these barriers, which are disturbing to many, are eventually overcome.

Suppose, however, that strong motives are blocked by impassable barriers; or by barriers which we cannot circumvent. It is then that such terms as *frustration*, *stress*, and *conflict* are most appropriately applied. All such terms mean about the same thing. We may speak of a *frustrating situation*, which is comparable with a *barrier* or *obstacle*, and we may speak of the *frustrating experience*. This is comparable with what is otherwise designated as psychological stress (*distress*) or *mental conflict*.

Frustrating situations (barriers) may be nonsocial or social. Nonsocial barriers are exemplified by transportation breakdowns, floods, storms and power failures. Social barriers are placed in our way by other people. These barriers play an important part

in our socialization, in the development of our ego and superego. They are operative when parents force the child to sit on the toilet, when they enforce cleanliness, and when they make him refrain from sex play. Social barriers are also present when a parent makes the child stay in his room or forces him to study instead of watching television. They are present, too, when the instructor sets an exam for the day that a student expects to take a trip. Moreover, the prejudices of his society may restrict a person's companions to those of a particular racial or socio-economic group. They may prevent him from getting the education he desires, or from entering a particular occupation.

Psychologically speaking, such factors as we have mentioned are barriers only when the individual has goals which are blocked by them, and when he is aware of the fact that they impede progress toward these goals.

In addition to external barriers (social and nonsocial) there are internal, or personal, barriers. Personal defects are of this nature, especially when they thwart our aspirations. Weakness, unattractiveness, lack of skill, or low intelligence may stand in the way of achievement. Deformities may prevent us from engaging in athletics, from following certain occupations, and even from marrying. Barriers like these are often much more lasting than those imposed from without. Here again, however, we must emphasize the fact that there is no psychological significance to barriers which the individual himself fails to recognize. Feeble-mindedness, for example, makes a college career impossible. In this sense, it may be considered an impassable barrier. But it is not frustrating to the feeble-minded individual himself. He knows little or nothing of colleges. They are beyond his comprehension. Nor does he have insight into his defect, his inability to do what college students do. But to his parents, who know the circumstances, and who may at one time have had aspirations for their child, his feeble-mindedness may be frustrating indeed.

Even when we are not frustrated by personal defects there may be internal conflict — a conflict between different motives, or their expression. Inability to “make up our minds” on some issue demanding decision exemplifies such conflict. The presence of conflicting possibilities of action may be even more frustrating than any of the barriers already mentioned.

People differ a great deal in how they cope with frustration. In apparently similar circumstances, some give up, some persist in their endeavors, and others break under the stress.



## BARRIERS

Barriers, as we have seen, are the more or less insurmountable obstacles, nonsocial or social, external or personal, which interfere with achievement of needs and aspirations. Such barriers may be represented diagrammatically as illustrated in Figure 8.1. If a barrier is readily circumvented, it may be represented as in (A). Here the frustration, if present at all, is temporary. The person detours, thus achieving his goal with no more than delay, and the expenditure of effort. But if the barrier is a more or less persistent obstacle, it may be represented as in (B). Here circumvention is assumed to be impossible. The individual either has to give up his goal or suffer continuing frustration.

Objects or circumstances which serve as incentives are sometimes said to have *positive valence*, which means that they "attract" the person or that he will strive for their achievement.\* Objects which repel, or circumstances which the individual will work to prevent or obliterate, have *negative valence*. A barrier, standing as it does in the way of goal achievement, may readily acquire a negative valence, even though not previously regarded as repellent. If the barrier is unassailable, or if all routes to the goal necessitate approach to, or acceptance of, negative valences which are more potent than the positive valence of the goal, the goal may be relinquished, or the person may withdraw from the situation, either

by running away actually, or by indulging in the fantasy that the barrier does not exist or that it has been circumvented. As we shall observe in discussing compensation, a substitute goal may replace that originally present.

## CONFLICT

We have said that indecision acts like a barrier in that it delays or prevents action. This occurs in situations where the individual must choose between alternatives and also in those where what he wants to do has undesirable as well as desirable consequences.

Let us first look at situations involving alternatives. Basically, such situations involve either an *approach-approach* or an *avoidance-avoidance* conflict.<sup>2</sup>

### Approach-approach

In an approach-approach conflict the person (P) is between two alternatives with equally positive valences. This may be represented as follows:



If the alternatives were not equally attractive there would be no conflict. The greater attractiveness of one alternative would, so to speak, "pull" the individual in its direction. Suppose, for instance, that a student who is poor at mathematics and who does not like this subject, is trying to decide between equally attractive colleges. There would be considerable conflict until he learned that one required mathematics for graduation and the other did not. In many situations of everyday life we are "pulled" in various directions and, as a result, we hesitate, vacillate, or perhaps find ourselves temporarily unable to act (Figure 8.2). We say "temporarily" because conflicts of this kind are usually soon resolved. The legendary ass, flanked by equally enticing and equidistant bales of hay, is said to have starved in the midst of plenty. But there is no doubt that, in the course of his vacillation, his head got closer to one bale. Its closeness would give it an advantage over the other if for no other reason than that its attractive odor became more intense. The man who cannot decide whether he will propose to Jane or Mary may delay action, and even lose some sleep,

\* Professor Lewin's so-called "vector psychology" is responsible for the psychological concepts of valences and barriers.<sup>1</sup> He regarded the outcome of situations like those presented here as the resultant (vector) of the attracting (+) and repelling (-) aspects of a situation, as it is experienced by the behaving individual. It is perhaps obvious that what repels one person may attract another, and that an attractive (or repelling) situation may vary in the "magnitude" of its valence for different persons. Hence the "forces" concerned do not reside in the physical environment alone but in the environment as the individual perceives it. They are derived from its meaning for him. The "frame of reference" is, in other words, individualistic or personal rather than physical. A very readable envisagement of psychology in these terms is to be found in Snygg and Combs' *Individual Behavior* (Rev. Ed.). Harper, 1959.



**8.1 Barriers to Ongoing Activity.** The barrier in either case may be an external hindrance, social or nonsocial, or it may be a personal defect. It could be indecision where conflicting motives, such as whether to marry Mary or Jane, delay or prevent achievement of the goal, in this case marriage. In **A** we represent a barrier which may more or less readily be overcome or circumvented. The individual is shown as varying his attack upon it until he finds how to reach his goal. In **B** the barrier is to be regarded as insurmountable. The individual's attacks upon it are of no avail. Negative signs indicate that it acquires repelling properties. These may become stronger than the positive attraction of the goal, leading the person to relinquish his goal, to give up his aspirations. (Adapted from Maier, 4.)

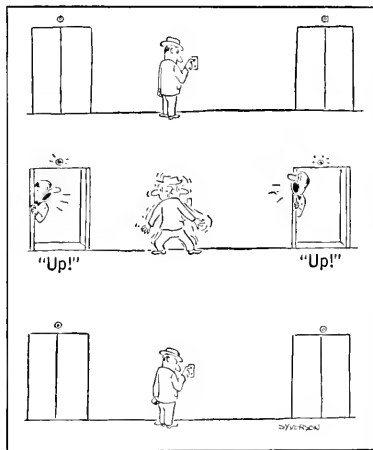
but when he is with Jane, Mary's attraction weakens or becomes stronger, depending upon the circumstances. After a certain amount of further experience with each, he finds that one is more desirable than the other and his conflict is resolved.

#### Avoidance-avoidance

In avoidance-avoidance conflict the alternatives are equally unattractive, or repulsive, and the situation in which the person finds himself may be represented as follows:



A student for whom study is distasteful finds that he must study or suffer the equally distasteful consequences of failing the course. A youth does not want to "drag race," because he is afraid for his life and knows that he is breaking the law, but he also does not wish to be regarded by his buddies as "chicken." The man who has had too much to drink with "the boys" knows that he will "catch hell" if he doesn't go home, and also if he does. In such situations we are "between the devil and the deep blue sea." It is common, under such circumstances, to "leave the field." The student perhaps daydreams about more pleasant

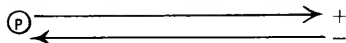


**8.2 Conflict.** (Reprinted by special permission of *The Saturday Evening Post*. Copyright 1949 by the Curtis Publishing Company.)

things than studying, examinations, and flunking out of college; the youth perhaps finds that his car isn't functioning just right, or remembers an important date elsewhere; and the inebriate perhaps has another drink so that he is too far gone to suffer the unhappy consequences of his drinking, at least for the time being. Lapses of memory are sometimes brought on by such conflicts.

### Approach-avoidance

There are many situations which have both positive and negative valences, as follows:



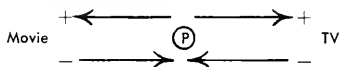
The would-be swimmer runs toward the icy water but, when he gets his foot into it, quickly withdraws. The child starts to pat a dog but is afraid to do so and pulls back its hand. A boy starts to climb a tree, but as he gets higher, he feels that he may fall. If such positive and negative valences are equally strong, the individual suspends action or vacillates. The swimmer goes toward the water and then away from it repeatedly until he "gets his courage up" or until others arrive on the scene and perhaps exert social pressures. The child hesitates to pat the dog, and he may not do so, unless he sees that someone else is patting it and does not get hurt. The climber may continue to climb because he sees an intriguing bird's nest.

Somewhat comparable conflicts at the adult level are inability to make up one's mind about an attractive job offer because one fears that he may fail; or hesitating to propose to a girl because one has doubts about his ability to make her happy. In such instances, the person may provide himself with some safeguard, thus reducing the negative valence. The first man may find that he can take special training to equip him for the job; the second may seek advice from a counselor and perhaps prepare himself for marriage.

A disturbing form of conflict resembling approach-avoidance is that in which the individual has both positive and negative attitudes toward the same person. A girl may have a great deal of affection for her mother, yet also hate her intensely for some particular reason—because she thinks that her mother fails to

appreciate the good qualities of her father, or because the mother interferes too much in her personal affairs. Parents love their children yet are so angry with them at times that they inflict cruel punishment, and may even have an inclination to kill them. This kind of mental conflict, known more specifically as *ambivalence*, is often accompanied by great mental stress. The individual fully appreciates that one is supposed to love his parents and his children, hence he becomes extremely worried when such conflicting impulses arise.

In many situations of everyday life we are confronted with various possibilities of action and each of these may have both desirable and undesirable aspects. Shall we go to the movie or watch TV? The movie is one we don't want to miss, and this is its only showing. But we are also short of cash. The TV program perhaps cannot be seen again. But we can't see it and also the movie. If we watch it, though, we will save our money. The situation is something like this:



What we do under such circumstances depends upon the relative strength of the positive and negative valences, unless visitors come, in which case we either watch the TV program with them or give up this and the movie too. Such conflicts are often referred to as *double approach-avoidance*.

As we continue our discussion of conflict it will become apparent that many situations involve a variety of attracting and repelling features and thus do not readily yield to the sort of analysis that we have described. The case to be discussed presently is a good illustration of such motivational complexity.

### SEVERE FRUSTRATION

There are many situations in adult life where no escape from external or personal barriers, or from conflict situations, seems possible. Sometimes, in such circumstances, the pressures are so intense that a person feels trapped.

Frustration and the resulting stress are inevitable aspects of everyday life. As we have said, some people can "take it," while others "go to pieces." Those who stand a great

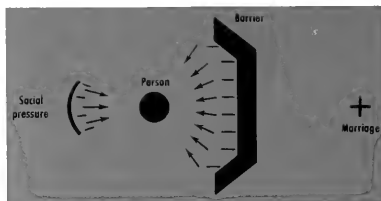
deal of serious frustration without breaking down under the stress are said to have a high *frustration tolerance*, which is defined as "capacity to withstand frustration . . . without resorting to inadequate modes of response."<sup>3</sup>

#### An example of severe frustration

One example from many that we might choose is the case of a man who once came to the writer for aid. Whenever this man became interested in a girl, his widowed and wealthy mother, who had encouraged financial dependence upon her and who had a heart condition, threatened to withdraw financial support. Without such support, marriage seemed impossible. Since the mother also had an aggravation of her heart condition at such times, the son felt that going ahead with marriage plans would perhaps kill her. He was in his forties. Crises of the nature described had been recurring for years, in each instance causing him to reject marriage. His desire to marry persisted, but so, also, did the seemingly insurmountable barrier. The mother continued to use her illness as a device to keep her son nearby and as a weapon to prevent him from getting lucrative employment. The son said he was trapped. Despite intense hatred for his mother, he could not bring himself to leave her, to thwart her wishes, or to do anything which might, as he said, make him feel for the rest of his life that he had been the cause of her death. This problem could be solved, apparently, only by the death of the man's mother or by her re-education. The latter seemed, at the time, hopeless. The man was advised to get married despite his mother. The suggestion that she would probably survive and that she would eventually become reconciled to his marriage did not seem convincing to him. His mother could not, so he said, do without his aid and companionship. He could not be near her and married too. Moreover, she had arranged to disinherit him if he married against her wishes. Her death as a result of his marriage would thus leave him penniless.

One will recognize that the barrier here was not the mother alone. It included the attitudes that she had implanted in her son.

Had the son become so involved with a girl that he was obligated to marry her, or



### 8.3 Situation Involving Extreme Conflict.

The barrier (in this case a man's mother and his attitudes) remains fixed and insurmountable. The goal (marriage) also remains. Without social pressure the son might evade the issue, going along with his mother's wishes. But with this pressure he is forced to do something, marry, with a resultant loss of his income and possibly of his mother; or not marry, with the resultant loss of standing in the community and of self-respect. The pressure is also negative in valence, because it forces him in the direction of unpleasant alternatives. (Adapted from Maier, 4.)

impelled by the pressure of public opinion to do so, and the maternal barrier remained, he would then have been in the plight represented in Figure 8.3. He would have had to choose between the conflicting alternatives. These could of course also be represented as in the double approach-avoidance paradigm above, with the alternatives being the mother and the wife or bachelorhood and marriage. However, there would be several positive and several negative valences associated with each alternative.

In frustrating circumstances like these, the term *mental conflict* is clearly applicable. The individual is indeed "between the devil and the deep blue sea." His distress is often acute.

#### Frustration and goal orientation

When frustrated, most people retain their goal orientation, attempting to discover a way out of their predicament or some means to diminish their distress. Even extreme frustration, like that suffered by the man whose case we have just considered, often fails to disrupt goal orientation. In many instances, how-



**8.4 Frustration-Aggression.** The cartoonist here expresses the basic idea of the frustration-aggression hypothesis; namely, that the person who frustrates us (in this case, quite innocently) becomes a target for aggression. When direct aggression is impossible, or fraught with danger to the aggressor, a scapegoat may be the target. (Copyright 1956, United Feature Syndicate.)

ever, the individual becomes panic-stricken and his acts defeat rather than further his aims.<sup>4</sup> Then he may "vent his spleen" on innocent people. He may even commit suicide.

#### Aggression as a frustration-instigated reaction

Aggressions, of which lynchings and wartime atrocities are extreme examples, stem from frustration and the resulting anger. Whether or not they serve any purpose, from the standpoint of the aggressor, is controversial. Aggression against innocent persons certainly serves no problems, but it may, of course, serve to release pent-up tensions in the aggressor (Figure 8.4). Even when this is so, aggression is hardly justified. The man who turns upon his child or his subordinates when frustrated by his wife, against whom he dare not aggress, may feel better, at least temporarily, but he has done nothing to solve his problem. Nor has the perpetrator of atrocities against individuals or groups. If anything, he has erected new barriers, the enmity of his victims and those who sympathize with them.

Whether frustrations are mild or of great intensity, a realistic goal-seeking approach is alone commendable. One should recognize that he is confronted with a problem to be solved and he should use all of the resources at his disposal or seek competent advice in an effort to overcome the obstacles.

Certain realistic reactions to frustrating situations such as we have described will now receive our attention. Some compensatory

reactions and subterfuges commonly observed under frustrating conditions will then be considered.

#### REACTING REALISTICALLY TO FRUSTRATION

The most direct reaction to frustrating external conditions is to remove or get around them. It involves trying out various procedures which might occur to us until one of them succeeds or until we are forced to give in. This may be an overt trial-and-error process or it may involve insight and reasoning.

Frustration from personal defects may be dealt with in a similar fashion, especially where the defects are remediable. One could not change his intelligence nor repair the ravages of polio by a problem-solving approach, but he might, if he knew it to be the source of his frustration, change some aspect of his appearance or behavior. Many girls make themselves more attractive to the opposite sex by experimenting with this and that cosmetic, this and that coiffure, or, this and that type of dress. Some colleges, through courses or in other ways, try to help the less attractive girls overcome their deficiencies.

The chief difficulty is that many individuals thwarted by personal defects do not realize the source of their trouble and quite often their friends hesitate to make any suggestions. As we shall point out in more detail shortly, those with personal defects are often ready to attribute their difficulties to almost anything else than to the defects in themselves.

When conflict comes from incompatible motives, a direct problem-solving attack may also be helpful. If one does not know whether he should prepare himself to be a teacher or a salesman, or whether to do his major college work in sociology or in psychology, he can at least gain as much relevant information as possible about these alternatives and perhaps also try his hand in each field.

Then, too, he may list the pros and cons and see where these seem to lead. Benjamin Franklin recommended this method in the following letter to Joseph Priestley: <sup>5</sup>

In the affair of so much importance to you, wherein you ask my advice, I cannot, for want of sufficient premises, advise you *what* to determine, but, if you please, I will tell you *how*. When those difficult cases occur, they are difficult, chiefly because, while we have them under consideration, all the reasons *pro* and *con* are not present to the mind at the same time; but sometimes one set present themselves, and at other times another, the first being out of sight. Hence the various purposes or inclinations that alternatively prevail, and the uncertainty that perplexes us.

To get over this, my way is, to divide half a sheet of paper by a line into two columns; writing over the one *Pro* and over the other *Con*. Then during three or four days' consideration, I put down under the different heads short hints of the different motives, that at different times occur to me, *for* or *against* the measure. When I have thus got them altogether in one view, I endeavor to estimate their respective weights; and where I find two, one on each side, that seem equal, I strike them both out. If I find a reason *pro* equal to two reasons *con*, I strike out *three*. If I judge some two reasons *con* equal to some *three* reasons *pro*, I strike out five; and thus proceeding, I find where the balance lies; and if after a day or two of further consideration, nothing new that is of importance occurs on either side, I come to a determination accordingly. And tho' the weight of reasons cannot be taken with precision of algebraic quantities, yet, when each is thus considered separately and comparatively, and the whole lies before me, I think I can judge better, and am less liable to make a rash step; and in fact I have found great ad-

vantage from this kind of equation, in what may be called *moral* or *prudential* algebra.

This method works very well providing the pros and cons do not balance. If they do balance, then the individual is back where he started.

### CONSEQUENCES OF UNRESOLVED CONFLICT

When frustration is prolonged and no resolution occurs, there is usually a condition of chronic emotional tension, sometimes referred to as *stress*. The latter is defined by Dr. Hans Selye in his book *The Stress of Life* as "the bodily changes produced, whether a person is exposed to nervous tension, physical injury, infection, cold, heat, x-rays or anything else. . . ." <sup>6</sup> One reason for lumping all of these unusual conditions together as "stressors" is that all of them tend to produce a homeostatic change in the body which has been referred to by Selye as the *general adaptation syndrome*, abbreviated G.A.S. A *syndrome* is a particular pattern or grouping of symptoms. The appearance of such symptoms is first evident in what has been called the *alarm reaction*, a "generalized call to arms of the defensive forces in the organism." <sup>7</sup> Among these defensive forces are increased secretions from the pituitary (ACTH) and the adrenal glands (cortisone). Continued stress enlarges the adrenals and certain other organs. Moreover, when the adrenal glands are removed, the organism's ability to withstand stress is greatly impaired. Increased secretion of cortisone, stimulated by ACTH from the pituitary (see p. 240), as well as various other stress-reducing changes, make it possible for the organism to enter a second stage of the G.A.S. This is an "emergency" reaction referred to by Selye as *resistance*. But stress may continue, the individual's psychological and physiological resources being insufficient to overcome it. In this event, a third and final stage of the G.A.S. is reached. Selye refers to it as *exhaustion*. With respect to the function of the adrenal cortex, for example, the course of the G.A.S. is described as follows: "the adrenal cortex first discharges all its microscopic fat granules which contain the cortical hormones (alarm reaction), then it becomes

## 8.5 An Avoidance Situation which Produced Ulcers.

When the monkey at the left pressed a lever at proper intervals, it postponed on electric shock for both itself and its partner. This "executive" monkey developed ulcers. The partner's lever had no function and was soon ignored. This animal, with no avoidance behavior, failed to develop ulcers. Courtesy of the investigator, Dr. J. V. Brady, and the Walter Reed Army Institute of Research, Washington, D.C.)



laden with an unusually large number of fat-droplets (stage of resistance) and finally it loses them again (stage of exhaustion). As far as we can see, the same triphasic course is followed by most, if not all, of the manifestations of the G.A.S."<sup>8</sup>

### Emotional stress and ulcers

One frequent outcome of prolonged stress, emotional or otherwise, is the production of gastric ulcers. According to Selye, this is due in part to the overactivity of the adrenal cortex.<sup>9</sup>

The first clear evidence that ulcers can be produced by emotional stress came from observations of a man whose stomach was exposed and whose gastric activities were thus observable. The accident giving rise to exposure of the stomach was described earlier (p. 185). During two weeks of prolonged anxiety, the subject developed small hemorrhages in the lining of his stomach and also a heightened gastric acidity. Something resembling a small ulcer finally developed and the investigators were impressed with the possibility that "the chain of events which begins with anxiety and conflict and associated overactivity of the stomach and ends with hemorrhage or perforation is that which is involved in the natural history of peptic ulcer in human beings."<sup>10</sup>

Since the above observations were made,

there has been additional direct evidence that psychological stress produces ulcers. In one experiment, nine hungry and thirsty rats were kept in a situation involving marked approach-avoidance conflict. They lived in a rectangular box with food at one end and water at the other. Both ends were electrified. When a rat approached either the food or water, it received a strong electric shock. The shock was on continuously for forty-seven hours, then turned off for one hour. This sequence was repeated for a period of thirty days. Rats of a control group lived in similar boxes, but without shock. Of the nine experimental animals, six developed gastric ulcers. Two of these died from hemorrhages toward the end of the experimental period. None of the controls developed ulcers. The three experimental rats which failed to develop ulcers received a respite on the twentieth day, and for three days thereafter. This was because the shocking apparatus connected to their boxes broke down. Perhaps this respite reduced their "anxiety level" and thus saved them from ulcers.<sup>11</sup>

An experiment somewhat comparable with the above has been done on monkeys. The monkey on the left in Figure 8.5 could escape electric shocks which came at twenty-second intervals if he pressed the lever at appropriate times. He was thus designated an "executive" monkey. The animal shown with him received the same shocks, when the

"executive" reacted inappropriately, but itself had nothing relevant to do. This monkey had the same kind of lever as the "executive," but this was not connected with the current and it was finally ignored. The investigators report that the "executive" monkeys developed ulcers while the others, even though punished for the "executive's" mistakes, did not.<sup>12</sup>

Although there is no indication that ulcers in human beings are always produced by emotional stress, there is no doubt that they occur more frequently in people undergoing prolonged anxiety than in those who are more serene. One clinical study showed that, of seventy-five persons suffering from critical stages of ulcer, sixty-three had been subjected to unusual anxiety. This involved financial difficulties in some instances, but in others there had been family conflicts and worry over real or imaginary illnesses.<sup>13</sup>

A relatively new field of investigation and clinical service known as *psychosomatic medicine* has called particular attention to the bodily harm that protracted emotional stress can cause. Development of ulcers is only one of these harmful effects. Among others that have been attributed wholly or in part to emotional stress are sinus disorders, asthma, high blood pressure, and certain skin disorders.\*

#### Escape from conflict

Studies of emotional stress have demonstrated that continued conflict, in addition to being unpleasant, is also deleterious to physical health, but a certain amount of conflict is perhaps inevitable and there may be some conflicts from which we cannot escape through any effort of our own. The man "trapped" by his mother in the case already described was in a dilemma from which he saw no way of es-

cape. It is quite evident, however, that many conflicts may be resolved if the individual assumes a problem-solving attitude toward them. Students often worry about such relatively simple problems as getting assignments done on time. Obviously the best way to remove such conflicts is to stop procrastinating and go to work on the assignments, thus getting them out of the way. The best corrective to worry over a difficult decision is to make the decision as soon as possible — perhaps utilizing Benjamin Franklin's method of balancing the pros and cons. When conflicts are more serious and we cannot solve them on our own, it is always well to seek professional guidance, thus alleviating the stress and its inroads on mental and bodily health.

When conflicts are not resolved in the direct ways already suggested, various indirect reactions or subterfuges are often utilized. These are goal-directed, in that they *seem* to alleviate or to solve the problem. Some have been called *ego-defensive* or *compensatory*, since they defend the person's self-esteem (his ego) in situations where, without such defenses, he would be forced to admit ignominious failure. The goal of much behavior anyway is not so much some aspect of the immediate situation as it is the enhancement of self-esteem which comes with achievement.

Ego-defensive behavior is somewhat comparable with the compensatory (homeostatic) mechanisms which, as we have seen, underlie certain physiological drives. Psychologists have adopted the term *homeostasis* to represent, also, the compensatory reactions aroused when self-respect is threatened. One psychologist prefers the term "autocorrectivism," which has a very similar meaning. Human beings compensate in many ways, as we shall now see.

#### COMPENSATORY REACTIONS

The term *compensation* is most often used in psychology to refer: (1) to emphasis of a different motive when expression of one is blocked or (2) the substitution of one means of expressing a motive when another more direct means of expression is not possible. In both instances we have substitution — either of another motive or of a new form of expression of the same motive.

\*Lucy Freeman in her book *Fight Against Fears* (Crown) tells how a resolution of conflicts achieved during psychoanalysis improved her sinus trouble and also her social adjustment. A research chemist under the pseudonym of John Knight has written *The Story of My Psychoanalysis* (McGraw-Hill). This tells how conflicts which aggravated an ulcer were alleviated, with a subsequent improvement in physical and mental well-being. Good technical discussions of such psychosomatic disorders will be found in Flanders Dunbar's *Mind and Body* (Rev. Ed.). Random House, 1955.



As an example of the first type of compensation we may take the man who, because his sex motive is thwarted, emphasizes strenuous athletics, or the unattractive girl who emphasizes scholarship.

Examples of the second form of compensation are found in the woman who desires children, but is unable to have any of her own, hence enters kindergarten work; the business man who, after having a morning scrap with his wife in which he couldn't answer back, takes it out on his employees; the individual whose desire for new experience is thwarted except when he reads a novel, or, better still, goes to the movies — where he can, vicariously at least, go on a safari through the jungles of Africa, man a machine gun on the deck of a plunging battleship undergoing air attack, or carry on a flirtation with Brigitte Bardot; the parent who, unable to have a college education himself, makes sacrifices so that his son can go, and then experiences vicariously all of his son's failures and successes; and the man who, in a gabby world, finds joy in belonging to a secret society, or, in a humdrum world, can join a lodge and be a Thrice Exalted Knight of the Enchanted Realm. All of these are examples where one expression of a motive is blocked, but another expression serves, in some respect, the same purpose.

The man who satisfies his desire for new experience by following the hero of a novel or movie, and the parent who experiences the successes and failures of his child as though they were his own, are *identifying*. We say that the individual identifies himself with the character in question. People often have palpitation of the heart, weep, grimace, and even cry out when identifying with characters in movies or on the stage. Sometimes identification is with an institution rather than with an individual. Thus a certain low-paid and academically frustrated instructor in a very large university got compensation out of the fact that he was connected with a university having many thousands of students. The bigness of the institution in which he taught was, for him, the only consoling aspect of his predicament. It bolstered his ego where his academic rank and his salary did not. Membership in a certain fraternity, lodge, or other organization having great prestige often serves a similar function. The member feels himself a bet-

ter, more successful person, because of his affiliation.

## FANTASY

Fantasy may also be compensatory. This is a form of dreaming (day or night) where we go through certain acts in imagination. It plays an important role in human life, and especially as an outlet for the frustrating circumstances of everyday experience.

When hostility resulting from frustration is not expressed in hostile acts, it is often represented in fantasy. Such "fantasy aggression" is revealed in projective activities like drawing, doll play, and telling stories based upon pictures (thematic apperception). Fantasy also plays an important role in poetry, painting, and in the arts in general.

The "angry boy" of a documentary film described earlier hated his mother, his teachers, and other children. His spontaneous drawings were of maimed and bandaged people and of houses and cities being destroyed by bombers flying overhead. One evidence of the effectiveness of psychotherapy in reducing his hostility was the fact that he began to draw pictures of children happily at play.

In using doll play as a projective test one often finds evidence of fantasy aggression like that illustrated in Figure 8.6. Here the child has been given a stylized doll's house representing the layout of its own preschool. There are school fixtures, two teacher dolls, and six preschool children dolls. The child tells a story and arranges the items to conform with its theme. What is implied by the arrangement illustrated is that this child is hostile toward teachers and boys, undoubtedly because these have in some way frustrated her and made her angry.<sup>14</sup>

Themes of aggression have been prominent in studies of adolescent fantasies. Adults often react in a comparable fashion, getting aggressive themes out of picture after picture of the Thematic Apperception Test (p. 246).

In their waking fantasies, adults have images of themselves retaliating for real or fancied wrongs. A good illustration of this occurs in Charlie Chaplin's film, *The Circus*. Rex, the man on the flying trapeze, a hefty and handsome fellow, has taken away Charlie's girl. Charlie, in the depths of melancholy, is

**8.6 An Example of Projective Doll Play.** This is an instance of what Bach characterizes as "Hostile Fantasy Aggression." One teacher is "burning" on the stove, another's head is pushed into the toilet, and a boy is squeezed under a wash basin. (From G. R. Bach, 14.)



watching them. Suddenly we see a ghostlike Charlie emerge from himself, go up to the rival, knock him out, and walk off with the girl. But as Rex actually begins his descent from the trapeze, the shadowy assailant retreats into the real Charlie, who is as despondent as ever. We all indulge in this sort of fantasy, especially when frustrated. It sometimes involves an imaginary conversation with the person responsible for, or involved in, our difficulties.

### Dreams

Dreaming is a form of fantasy which, like daydreaming, often gets its impetus from personal problems. Freud<sup>15</sup> regards the dream as a wish-fulfilling device, and also as a guardian of sleep. For him, "every dream is an *attempt* to put aside a disturbance of sleep by means of a wish-fulfillment." Our biological urges (represented in Freudian theory by the id) demand satisfaction. This demand is made upon the sleeping ego. Sometimes it stems from doubts, conflicts, or inability to reach decisions. "The sleeping ego," according to Freud, "is focussed upon the wish to maintain sleep; it regards this demand as a disturbance and seeks to get rid of the disturbance. The ego achieves this by what appears to be an act of compliance: it meets the demand with what is in the circumstances the innocent fulfillment of a wish and thus disposes of the demand. This replacement of a demand by the fulfillment of a wish remains the essential func-

tion of dream-work." Examples of dreams having this function would be found when a person who is hungry dreams of going to the ice-box and having a meal; when the time to wake up and go to work has come but the worker merely dreams that he is up and on his way; and when the person who is sexually aroused dreams that sexual desires are being satisfied. In each instance, satisfying the demands of such situations directly would mean waking up. By satisfying them symbolically, as in the dream, the person's sleep is safeguarded.

There is no doubt that many dreams can be given this interpretation. It is not surprising, therefore, that psychoanalysts use dream analysis in seeking to discover the desires, frustrations, conflicts, and anxieties of their patients. We saw earlier (p. 18) that dream analysis is used both to diagnose and treat certain personality disorders. It was involved in the diagnosis and therapy of the psychosomatic disorders mentioned in the preceding footnote (p. 216).<sup>\*</sup>

<sup>\*</sup> There is an extensive theoretical and experimental literature on dreams, quite apart from that dealing with dream analysis and personality. Dreams are often aroused experimentally, by stimulation of the sleeping subject. They may also be induced hypnotically. Some studies deal with aspects of dream imagery (for example, with its color or lack of color). Others concern the duration of dreams. Still others deal with the relation between dream content and stimulating circumstances. One of the most extensive studies is that of Calvin S. Hall, entitled *The Meaning of Dreams* and published in 1953 by Harper.



**8.7** A Picture Used to Elicit Stories Which Could be Scored for Achievement Imagery. Stories created by different subjects in response to such pictures are given in the text. (Photo courtesy Dr. D. C. McClelland.)

Fantasy may be expressed in fiction and other products of creative imagination. Psychiatrists and psychologists have analyzed such products in an effort to discover thereby the basic motivation of their creators.<sup>16</sup> Many artistic creations may be regarded as compensatory. Some are indirect socially acceptable expressions of frustrated love, homosexuality, aggressiveness and other hidden motives. Freud coined the term *sublimation* to represent the various indirect socially acceptable expressions of frustrated motives. While sublimation may occur in fantasy it sometimes appears in overt behavior, as when a sadist becomes a boxer, a dentist, or even a surgeon.

#### Laboratory investigations of fantasy

Subjects have been required to make up stories about pictures. In such investigations,

special interest has been attached to the possibility that fantasies might be manipulated in predictable ways by altering a person's motivation. One such investigation<sup>17</sup> showed that subjects deprived of food for periods up to sixteen hours, used more food imagery than occurred under normal conditions. This is reminiscent of the finding (p. 144) that semistarved men become preoccupied with thoughts of food and things associated with it. It is also in line with the commonplace observation that the conversation of hungry people often turns to food. One is reminded, too, of the pin-up girls favored by frustrated males and of such songs as *South Pacific's* "There Is Nothing Like a Dame."

Our society places a great deal of emphasis upon getting ahead, making something of oneself, or obtaining recognition; thus instilling an *achievement motive*. Laboratory investigations have shown that this motive may be manipulated in such a way as to change the subject's fantasies. Pictures like that illustrated in Figure 8.7 were used. Male college students looked at such pictures and then answered the following questions: What is happening? Who is the person? What has led up to this situation? That is, what has happened in the past? What is being thought? What is wanted? By whom? What will happen? What will be done?

The subjects were told that they were being tested for creative imagination. There were thirty-nine students in each of three conditions (relaxed, neutral, and ego-involved). Each subject made up a story about each of four pictures.

Subjects tested under the *relaxed* condition were told that the investigator was a graduate student trying out various tests in the developmental stage. The investigator joked, showed no concern for the outcome of the tests and did not ask the subjects to sign their names. The picture tests were given along with an assortment of others (anagrams, scrambled words) which actually had no significance in the experiment.

The *neutral* condition was designed to produce normal motivation such as usually exists in the classroom. Thus the investigator was presented as a graduate student gathering data for his Master's thesis. He said that he wanted to establish some norms, and he asked for

serious cooperation. Again the unrelated tests were given along with those on "creative imagination."

Under the *achievement-oriented* condition, every effort was made to get the subjects ego-involved. The investigator ostensibly came from another university. The subjects were told that the tests were for the purpose of measuring their intelligence and that these were being given under the auspices of the Office of Naval Research with a view of discovering men with leadership qualities. These and similar remarks were calculated to arouse the achievement motive. The pictures and associated tests were identical with those used in the other groups.

That the latter condition aroused more achievement fantasy than the other conditions, and considerably more than the relaxed condition, is shown by the results summarized in Figure 8.8. The neutral condition might be expected to involve some such achievement motivation as is normally present in ordinary classroom conditions. But when scores for achievement imagery were combined for both the neutral and achievement-oriented conditions they were found to differ significantly from the scores for the relaxed condition.

Some stories scored as having achievement imagery are as follows:

The boy is a college student. He is trying to recall a pertinent fact. He did not study this particular point enough for an examination he has to take. He is trying to recall that point. He can almost get it but not quite. It's almost on the tip of his tongue. Either he will recall it or he won't. If he recalls it, he will write it down. *If he doesn't, he will be mad.*

The italicized words suggest competition with a standard, which is of course achievement motivation. In the following example, the italicized words suggest "unique achievement."

The boy is a student and doing a boring clean up job. His mind is going off on a tangent, and he is daydreaming. He has just come from a class in medieval history, and the instructor's reference to the knights of old has made the lad project himself into such a battle arrayed with armor and riding a white stallion. The boy is thinking of riding out of

the castle, waving goodbye to his lady fair, and going into battle and accomplishing many heroic deeds. The boy will snap out of it when he sees his boss coming along and will become frantic, realizing he has not been paying attention to his work.

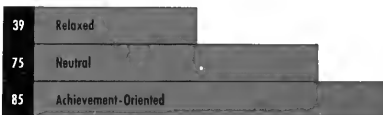
Achievement imagery with "long-term involvement" is illustrated in the following excerpts from stories:

*The boy is thinking about a career as a doctor. He sees himself as a great surgeon performing an operation. . . .*

*A boy is to take an examination for entrance into the Army Air Corps. He has studied very hard in high school hoping all along that he will someday be a fighter pilot. . . .*

The boy is a thinker. . . . He has faith in his capabilities and wants to get started on the job he has lined up, dreaming of advancements. . . .<sup>18</sup>

Stories like these may tell the investigator a great deal about the motives, values, and ideals of the person who creates them. This aspect of such studies is discussed in the chapter on personality. Here our prime interest is to show that fantasies, being related to motivation, may be manipulated through experimental changes in motivating conditions.



**8.8 Effect of Motivation on Fantasy.** Each bar represents the frequency of achievement imagery elicited under each of the three conditions. The highest possible frequency would be 156. This is because there were 39 subjects and each reacted to four different pictures. Observe that the achievement-oriented condition aroused 85 instances of achievement imagery out of the possible 156. (After D. C. McClelland et al., *The Achievement Motive*. Appleton-Century-Crofts, 1953, p. 141.)

Fantasy becomes dangerous, from the standpoint of mental health, when it loses contact with reality by dealing with desires impossible of fulfillment; when it involves impractical solutions; and when it is continually substituted for the real thing, thus preventing an actual adjustment. Mental hospitals contain many whose dreams "have come true" to them. They have, as we say, "escaped from" or "lost contact" with reality. One patient, who said he was Clark Gable, claimed that he could make himself smaller than a keyhole, yet he demanded that the authorities let him out.

### BELITTLING AND BLAMING OTHERS

These reactions are also compensatory. They are ways of maintaining self-respect in the face of failure. The person whose ego is badly deflated often inflates it, so to speak, by thinking of or pointing out the faults of those who have succeeded where he has failed. Thus, the girl who fails to get into a sorority may point out that those who do so are a lot of handshakers, that they think more of politics than of scholarship, or that they are too cliquey a bunch anyhow. This makes her feel a little more happy with her lot. It may go to such an extreme that she is "glad" she didn't get in with such a bunch.

Students who fail courses, for example, often say that they had a "punk" teacher, that the text was beyond comprehension, or that their class came at a bad hour. Sometimes they are right. In the majority of instances, however, such students are attempting to maintain self-respect at a high level by refusing to recognize their own faults. A student once said that the writer's chief weakness was an inability to make up exams that students like her could pass.

Blaming others is a dangerous reaction. Like excessive unrealistic daydreaming, it may lead to insanity. Mental hospitals contain many people who place responsibility for their troubles upon others. They accuse others of putting ground glass in their food, of poisoning them, of throwing radio waves on them, and of perpetrating other criminal acts. It is apparently easier for them to do this than to admit their own shortcomings and correct them.

Another important compensatory reaction is *overcompensation*. Like other compensatory phenomena, this is associated with efforts to overcome threatened inferiority or threatened loss of self-respect. It is associated especially with conflict due to personal defects. As the name implies, overcompensation is a tendency to do more than remove the defect. The former weakling who does not stop when he has developed a normal body, but strives to become the "World's Strongest Man," is overcompensating for his original defect. Theodore Roosevelt and Helen Keller exemplify people who more than overcame their physical defects. Louise Baker's *Out on a Limb*<sup>19</sup> is an interesting account of how one girl, who lost a leg in childhood, made herself a one-legged celebrity. At the end of this biographical account of her life, the author implies that if she had possessed two legs, she would have had nothing interesting to write about. Many "ugly ducklings" have become great actresses, and many people of small stature (Franco, Mussolini, Napoleon — to mention but a few) have become dictators or great military leaders. Many of the radicals in politics are obviously overcompensating for feelings of inferiority. A book dealing with psychology in politics traces the radical tendencies of several such individuals to childhood frustrations.\*

A form of overcompensation, but in reverse, is *self-repudiation*. The individual says, "Oh, I'm terribly dumb." "You know, I'm awfully homely," or, "I'm just not good for anything." The answer they desire is, "Of course you're not dumb," "I think you're beautiful," or "You may not be able to cook, but you're a sweet little woman just the same." In many such instances the individual does not really feel inferior, but is merely "fishing" for compliments. He is rudely disappointed if the other person says, "That's right, you *are* dumb."

When self-repudiation develops to an extreme degree we find people accusing them-

\* Lasswell, H. W., *Psychopathology and Politics*. University of Chicago Press, 1930; also see H. Cantil, *The Psychology of Social Movements*. Princeton University Press, 1941, and G. M. Gilbert, *The Psychology of Dictatorship*. Ronald, 1950.

selves of sins, which they may or may not have committed, and spending much of their time weeping and wailing. The writer knew one old lady who said sin had caused her to "lose her soul." She repeated over and over, "Lost my soul, lost my soul, lost my soul." She regarded any effort to keep alive as a sin, so she would not eat or drink. Only forced feeding by means of a tube kept her emaciated body alive. Such individuals stoutly maintain their sinfulness in the face of all attempts to show that, after all, they are no more sinful than most people. Some seem to enjoy the unique distinction of being "the greatest sinner of them all." Such individuals get more attention and recognition than they would enjoy if they were normal. This is undoubtedly the motivation in many cases of self-repudiation.

### PROJECTING

Projecting is somewhat like the reactions already considered, in that it often has a compensatory function. We project whenever we attribute our thoughts or desires to others. Projection is also involved when otherwise meaningless situations are given meaning in terms of our own motives. It is for this reason that picture tests like those already discussed, and also considered in the chapters on personality, are said to be projective.

Projection is very often an indirect wish-fulfillment. Thus, the girl whose desire for response from men is frustrated may imagine that men have designs upon her. A college girl once known to the writer accused men of chasing her while she went home through a park. Upon investigation, however, it became apparent that she had not been chased. As the psychiatrist put it, "She wished that men would chase her, the wish was father to the thought, and her imagination got the better of her."

Projection sometimes comes from feelings of guilt. If one has done something of which he is ashamed, he may imagine that people have found it out, and he may see relevant significance in their actions. A person who "felt like spitting on himself" got the idea that men whom he passed on the street wanted to spit on him. A girl who was told, under hypnosis, that she had stolen some money was very depressed when awakened. She did



**8.9 An Example of Projection.** In the book that these subjects are looking at is a picture of a man sitting and another standing. The girl says that the man sitting is sad because the man who is standing is accusing him of something wrong he has done. Different people give different interpretations of this picture. The girl's interpretation is based upon a "guilt complex" as described in the text. (From the sound film "Unconscious Motivation," prepared by Lester F. Beck, and distributed by Association Films, Inc.)

not know why. When shown and asked to comment about two men in a picture (Figure 8.9) she saw one as sad and the other as reprimanding him. Later she said that the boy sitting next to her stole the money. She was obviously projecting her own depression and her own guilt.

In an experimental study of projection, fraternity brothers rated themselves and each other. Such traits as stinginess-generosity and bashfulness-forwardness were rated. Subjects who failed to see themselves as others see them — those who were relatively lacking in social insight — showed a marked tendency to rate others as they rated themselves. If one of these rated himself high on stinginess, for example, he rated others high on this trait; if he thought himself generous, he attributed generosity to others.<sup>20</sup>

Indeed, a person who feels guilty often les-

sens this feeling by imagining that others are guilty too. For example, the married woman who carries on a flirtation may accuse her husband of unfaithfulness, and the college student who cheats may say that his fellow students cheat when they get a chance to do so.

Like some other reactions already mentioned, projecting may lead to mental illness if carried to extremes. Many inmates of mental hospitals are there because they attribute their desires, their thoughts, and even their acts to others. One man said that his every act (even crime) was the "will of God." Another had shot at a girl whose impending marriage was just announced. He did this because, for the year or so that they had been passengers on the same streetcar, she "had deceitfully led him on by her actions." The girl hardly knew of the man's existence and had never given him any reason for his accusations, but her acts had been interpreted as having amorous reference to himself. Later, discussing delusions and direction in thinking (Chapter 12), we shall cite further instances of such projecting.

### RATIONALIZING

Rationalizing is faulty, defensive thinking motivated by the desire to retain self-respect. It serves this purpose, at least temporarily, by enabling us to avoid facing issues and to excuse our failures. Rationalizing often takes the form of "kidding oneself" as to the real motives for conduct.

Perhaps the most common kind of rationalizing is the attempt to justify decisions or actions by finding "good" reasons for them. A student knows that he should study, but wants to go to the movies. He resolves the conflict by telling himself that too much study will ruin his eyes, that he needs a rest anyhow, or that he'll be able to study even better the next day. Likewise, a married man who carries on affairs with other women than his wife saves his self-respect by concluding that "man is by nature polygamous" or that his wife doesn't really appreciate him anyway. Why doesn't he tell his wife about his unfaithfulness? If he did so, "she would feel unhappy" and "what she doesn't know won't hurt her." The girl who says, "Oh, I didn't want that man anyway—he'd perhaps have turned out no good," or, "Who'd want to join *that* soror-

ity?" is belittling others, but she is also rationalizing. This form of rationalization is very appropriately designated a *sour-grapes* reaction. It is obviously compensatory, since it eases the sting of defeat.

Rationalizing often begins at an early age. A three-year-old who did not want a neighborhood child of five to visit him because this child monopolized his "fire engine" was told that he must invite the other child to come over and have a ride. He said that the other boy might be having his nap. When told that the other boy was up, he said the sky looked as if it might rain. When he was told that it would not rain, he said that the boy's mother might not want him to come. He made one excuse after another, and never did get around to giving the child an invitation.

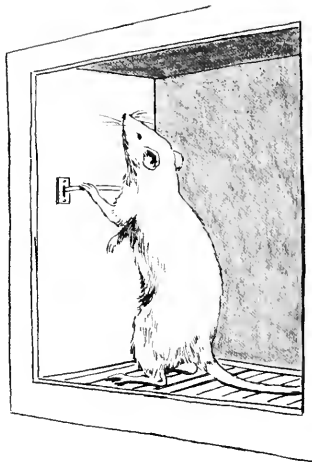
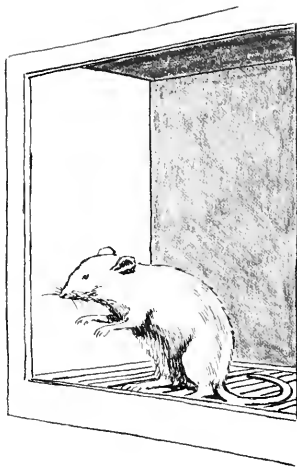
A child confronted by the alternatives of taking his teddy bear to school and being thought a "big boy" did not take the bear, but his excuse was that the bear might get a cold.

It is probable that children acquire this tendency to rationalize by copying patterns of rationalization set by adults. The "sour-grapes" pattern is obviously copied, for parents frequently tell a child, when they do not wish him to have something, that it is "no good," that it will "make him sick," or that boys who play with such things are "sissies." It seems only natural that, when frustrated under similar circumstances, he should tell himself things like these his parents have told him.

Rationalization is so prevalent a reaction to situations involving conflict that it cannot be regarded as abnormal. It is sometimes excused on the ground that it reduces the qualms of conscience or misgivings which all of us suffer from time to time. Some assert that "if we did not rationalize, we'd go crazy." There is at least a grain of truth in such assertions, but they are themselves largely rationalizations. There is no good substitute for facing life squarely and meeting difficulties realistically.

### REGRESSION

Whenever an individual confronted by difficulties "gives up" and reverts to such reactions as weeping, kicking objects around,



**8.10 Two Modes of Adjustment in a Regression Experiment.** The floor carried an electric charge, the effect of which could be diminished by sitting on the hind legs as illustrated. When a lever was inserted, the shock could be eliminated entirely by pressing it. Later, when the lever itself was electrified, the animal reverted to its original, less adequate, mode of response. (After Mowrer.)

stamping his feet, and even "cussing," he is regressing to an earlier, less adequate mode of reaction. These reactions perhaps release tension — help us "let off steam" — but they seldom solve our problems. We say "seldom" rather than "never" because many a child learns that temper tantrums or sulking get him the things he desires. He may, in fact, continue to use these long after adequate modes of adjustment are possible. Men and women often revert to these earlier responses when frustrated. Wives sometimes dominate their husbands, and husbands their wives, by fits of sulking, weeping, and threats that they will "do away with themselves" or "go home to mother" if they do not get their own way.

Psychologists have carried out several experimental investigations of regression in animal and human subjects. Emotion-provoking stimuli like electric shock, a cold shower, and a sudden loud noise presented just before the moment of response lead many subjects to re-

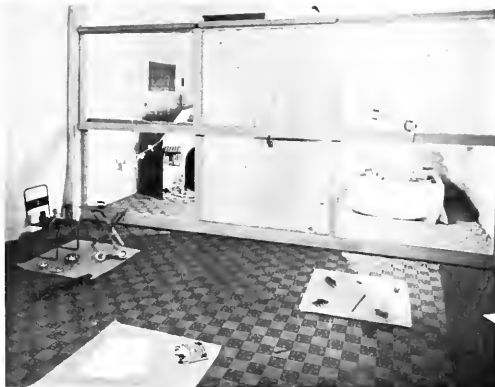
vert to earlier, less adequate forms of adjustment.<sup>21</sup>

One study with rats utilized an apparatus like that illustrated in Figure 8.10. There were two groups. Members of the experimental group were placed in the apparatus one at a time and given a continuous shock through the floor. The rats soon found that, if they sat quietly on their hind legs and held their forepaws off the floor, they received comparatively little shock. Eventually all of the experimental animals held this position, with occasional random activity, until the shock went off. The duration of the shock was fifteen minutes. We may designate assumption of the above posture as habit 1. Members of the control group were not given an opportunity to acquire habit 1. After a member of the experimental group had learned habit 1 it was placed in the same box, but now containing a bar, pressing of which terminated the shock. The rats soon learned to give up habit 1 in



## 8.11 A Frustrating Situation Which Elicited Regressive Play Behavior in Pre-school Children.

The screen, padlocked in the center, prevents a child from returning to the exceptionally attractive toys on the other side. His play with the toys in the foreground is now less constructive than it was before he knew about the more desirable toys, now seen but inaccessible. (From Barker, R. G., T. Dembo, and K. Lewin, 23.)



favor of this much more adequate response, designated habit 2. The control group also learned habit 2. Both groups, in fact, were trained until they had acquired equal efficiency in escaping shock by pressing on the bar. The crucial part of the experiment came when the bar itself was electrified, so that it administered a strong shock until pressure was applied. This brought considerable conflict. The subject could still terminate shock by pressing the bar, but touching it brought a strong shock in the forepaws. Under these conditions, four out of the five experimental rats regressed. That is, after contacts with the electrified bar, they returned to habit 1, merely crouching on the floor. All of the control rats, on the other hand, continued to press the bar.<sup>22</sup>

Children also exhibit regressive behavior when frustrated. The play activity of thirty preschool children was studied before and after a frustrating situation had been introduced.<sup>23</sup> The children were observed individually. Free play was observed, frustration was introduced, and play was again observed for a period comparable in length with the first. The situation is illustrated in Figure 8.11. During the free-play period, the child did not know of the farther room, since it was hidden by an opaque partition. After the free-play period, the partition was removed, disclosing the rest of the room. The child then spent fifteen minutes playing with the very enticing objects now displayed for the first time. These in-

cluded a doll's house with accessories of all kinds, a truck and trailer, a picnic table with accessories, and several other toys. After the child had played with these, it was returned to the other side of the room, with the less interesting toys, and the screen illustrated was lowered. Now the child could see the desirable objects, but the screen and a large padlock made them inaccessible. Two observers, one inside the room and one outside, but viewing it through a one-way vision screen, recorded the play activities. These were later scored in terms of constructiveness. Under free-play conditions before frustration, the average constructiveness score was 4.99. During frustration it dropped to 3.94, a change of 1.05 points which statistical analysis indicates is not due to chance. Of the thirty children, twenty-two regressed to the less constructive level, three did not change, and five increased their constructiveness.

### REPRESSION

Some people react to conflict situations by refusing to admit the existence of difficulties, of defects, or of particular motives. These people are said to be repressing. A jealous child who refuses to admit the existence of his baby sister is repressing. So also is the person who has conveniently forgotten some unpleasant obligation.

Repressing is not merely inhibiting, al-

though one may, in repressing, inhibit unpleasant thoughts. A clear case of inhibiting occurs when you decide to study instead of going to a movie. We may say that you inhibit movie-going activity, but it would not be correct to say that you have repressed such activity. Repressing would clearly be present, however, if you refused to admit the existence of the movie or of your desire to see it. In repressing, therefore, you close your eyes to reality.

What we put out of mind or try not to think about is usually the unpleasant. Sometimes we repress by dropping off to sleep. An old gentleman known to the writer always dozed off when he began to read something which seriously assaulted certain ideas to which he firmly held. Charles Darwin was so cognizant of this tendency to avoid or forget the unpleasant, and so intellectually honest, that he made a point of jotting down immediately any observation which failed to support his views. Observations confirming them needed no special attention.

Ego-defensive repression is interestingly demonstrated in an experiment involving failure to solve a series of jigsaw puzzles. College students were divided into two groups, members of each group being given a different "set" concerning the reason for giving them the task to be performed.<sup>24</sup> Members of one group were told that the experimenter wanted to classify the puzzles for further use and that their reactions would assist him. In this group, "interest was mainly centered on the task so that incompletion could mean very little beyond residual tension related to the problem in hand." Members of the other group were given the puzzles as an intelligence test. Thus they might be expected to assume an ego-defensive "set." The investigator says that under these conditions "incompletion would almost inevitably be experienced as failure." Members of both groups were permitted to finish half of the series, but were stopped midway in each of the remaining tasks. Later, each student was asked to name the puzzles attempted.

Earlier research on completed and incomplete tasks had shown that unfinished tasks are recalled more readily than finished tasks.<sup>25</sup> The hypothesis to be tested by this experiment was that: the "intelligence test" group, experiencing personal failure when prevented

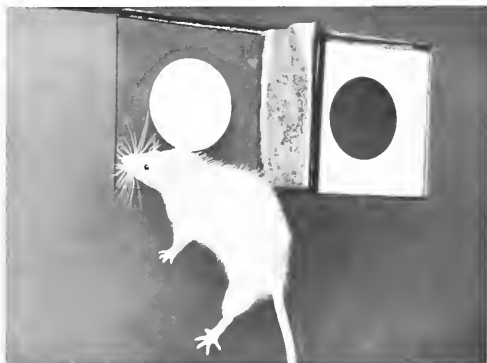
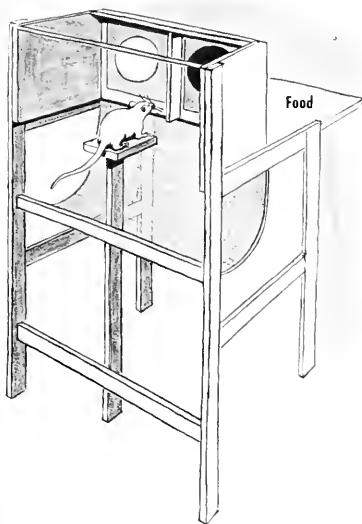
from completing tasks, would recall fewer unfinished tasks than the other group. The experimental outcome supported this hypothesis. Only eight out of thirty students given the puzzles as an "intelligence test" recalled a preponderance of unfinished tasks. This number is to be compared with nineteen out of thirty for the control group. A comparable outcome has occurred in two more recent experiments,<sup>26</sup> with different materials and somewhat different methods of producing a "threat to self-esteem."

Attempting to solve serious personal conflicts by repressing may have dire consequences. Many symptoms of neurotic behavior (pp. 255-258) result from repression. Among these are sleep-walking, amnesia (loss of memory — usually for unpleasant realities), multiple personality (coexistence of two or more personalities as in Dr. Jekyll and Mr. Hyde — where one aspect of the total person dominates and the other is repressed), and so-called functional paralyses and anesthetics (loss of ability to control certain muscles and loss of sensitivity, even though the organs concerned are structurally normal).

#### REACTIONS TO EXPERIMENTALLY PRODUCED CONFLICT

If a dog is trained to respond to a circle and not to an ellipse, and the ellipse is then gradually made more and more like the circle, a point is eventually reached where the animal does not "know" whether or not to respond. That is to say, it is unable to differentiate the two stimuli. When this point is reached, many of the animals suffer a "nervous breakdown." They may whine, struggle when restrained, refuse to eat, and show, in general, what might be characterized as "nervousness." Pavlov, in whose laboratory this type of reaction was first studied experimentally, thought that the breakdown resulted from a conflict between the tendency to make and the tendency not to make a response to the situation.<sup>27</sup> Many later writers have stressed the "conflict" basis of neurotic behavior in human beings.

\* One might expect that the group subjected to greater stress would recall more finished than unfinished tasks. This occurred in the experiment described, but later experiments have not confirmed it.



**8.12 Apparatus Used to Study Discrimination and Conflict in Rats.** When the rat jumps against the correct stimulus, he proceeds to the food platform beyond. A jump against the incorrect stimulus, which is locked from behind, brings a fall into the net below. The stimuli are shifted in position, in a chance order, from trial to trial. (After Lashley.) In the top picture at the right, a correct response is shown. The card falls and food is obtained. The lower picture shows an incorrect response, after the position of the cards has been changed. The rat bumps its nose and falls into a net. (From experiments by Dr. N. R. F. Maier. Photos Bernard Hoffman, *Life*, © Time, Inc.)

Behavior disturbances resulting from conflict have since been observed in several animals under a wide variety of experimental conditions. In one study, pigs were subjected to two different environments on alternate days.<sup>28</sup> A 600-cycle tone was sounded one day and a 750-cycle tone on the alternate day. On the day when the 600-cycle tone was presented, cessation of the tone for ten seconds served as a sign that an apple had been dropped into the food box. The animal lifted the lid with its snout and got the apple. On the day when the 750-cycle tone was presented, cessation

of the tone for ten seconds served as a sign that an electric shock to the foot was about to occur.

This training continued for months. Finally, the animal's performance was well stabilized. Whenever the 600-cycle tone stopped, it lifted the lid. Whenever the 750-cycle tone stopped, it lifted its foot and avoided the shock. Then a new condition was introduced. Random lifting of the lid during presentation of the tone on food days and at any time during shock days brought an electric shock. The animal then refused to lift the lid until the apple had

dropped. The experimenter, on the other hand, refused to drop the apple until the pig lifted the lid. This was apparently too much for the pig. It showed a marked tendency, first of all, to lift the lid and its foot at the same time, as if "torn apart." Finally, the animal showed "sulky" behavior, went into a sleep-like trance, and exhibited many other abnormal reactions.

Rats have also served as subjects in somewhat similar experiments. In one experiment the animals were trained to flex a leg whenever a bright light went on and to refrain from flexing it whenever the light was dim. The difference in brightness was then reduced until it became a difficult problem for the rat to differentiate. Was it to flex its leg or refrain from flexing it? Under these conditions, one rat seemed unable to inhibit leg flexion. It squealed and tried to avoid the experimenter's hand. Another seemed unable to flex its leg.<sup>29</sup> Somewhat similar conditions in a different experiment produced a rigid posture, in which the rat's whiskers were motionless. When removed from the apparatus, the animal maintained positions in which the experimenter placed it. Excessive urination and defecation, suggesting emotional upset, also occurred in such situations.<sup>30</sup>

In a jumping apparatus like that pictured in Figure 8.12, difficult or insoluble discrimination problems were presented and the rat was forced, by an electric shock, to jump toward the stimuli. The situation was somewhat comparable with that of the person represented in Figure 8.3 (p. 212), pressure being applied to force a response under circumstances where there was great resistance to such a response. Sometimes the animals *fixated*, that is to say, persisted in performing such inadequate responses as jumping always to the right or left, jumping too high, or jumping between instead of at the stimulus cards.<sup>31</sup> In another such study, the force with which the rat jumped from the platform increased as the problem became more difficult.<sup>32</sup>

When confronted with situations like these, rats sometimes exhibit behavior disorders culminating in convulsions similar to those of epileptics. One study confronted rats with negative stimuli only, so that jumping was inhibited.<sup>33</sup> The animals were then given an electric shock which forced them to jump.

Under these circumstances they became highly excited. One jumped to the floor, ran around with extreme speed, exhibited jerky movements (tics) and had a convulsion.

### CONFLICT, "WILL POWER," AND INITIATION OF ACTION

While they have wide popular usage, the terms *will* and *will power* are seldom used by psychologists, because they really explain nothing. To say that one "wills" to do something, or that he exerts "will power," tells us that he decides or intends to do what he does — that he is not doing it automatically or unthinkingly — but it does not tell us how his decisions are reached or how they are carried over into action. These are the crucial problems. We know much more about the basis of making decisions than we do about the carrying over of decisions into action.

#### The concept of will power

You are, let us say, confronted by a very difficult decision and, after much deliberation, you assert, "I will do so and so!" Or you are confronted by a very difficult task which will take years to complete. There are many temptations to quit or to put it aside, but you persist until the task has been completed. Or, to take one more of many possible examples, you are listening to an uninteresting lecture, but with great effort keep your attention on what the lecturer is saying. In each of these instances you have, it is claimed, used "will power." Will power is thus usually inferred when your decisions are difficult to make, or when you persist in your endeavors, despite distracting influences. It is never inferred when decisions are easily made or when behavior is lacking in persistence. Nor is it assumed to exist in animals below man. The mother rat may persist in gathering her young, despite the electric grid that she must cross in doing so, but we would not infer that she was using will power. Rather obviously, her behavior persists because the motive to get to her young is stronger than the motive to escape an electric shock.

Psychologists have come to regard the varieties of behavior attributed to "will power" as expressions of the relative strength of mo-

tives. If we think in terms of vector psychology the decision stems from the incentives having the strongest positive valence. In other words, those alternatives which, in terms of innate drives and past experience, promise the greatest ultimate satisfaction of motives, determine the direction of choice. To say that "will power" swings the balance is to say no more than that the decision was difficult, but that the motivation to perform one act was stronger than the motivation to perform the other. The Japanese soldier confronted by the imminence of capture had two alternatives. One of these was to save his life by surrendering. But this, in terms of his training from childhood, meant that he would lose self-respect and also the respect of his ancestors and associates. The other alternative was to kill himself. This, in terms of his training, meant that he would have everlasting glory and honor in the supernatural life that had been promised him. So the soldier killed himself. Because our training does not put life and death in the same light, it seems to us either that such people are "barbaric" or that they have exceptional "will power." Yet, almost anyone, if subjected to the same training, would find the alternative of killing himself much more desirable than that of living a life of disgrace.

A similar interplay of motives is involved whenever behavior persists in the midst of temptations to give it up. If you persist in your efforts to get a college education and put aside temptations to get married and quit, take a job which offers immediate financial rewards, or enjoy yourself at the expense of studying, it is probably because, as you think of the various alternatives, getting a college education exerts more "pull." You may be motivated by the desire to gain prestige, to prepare for further professional training, to please or not disappoint your parents, to finish what you have started, or by a combination of these or other motives.

Some of us find that persistence is made easier if we publicly state what we intend to do. Then, whenever associates ask, "How is that project going?" it acts as a spur to continued effort. By following this procedure, we put ourselves "on the spot." Most of us hesitate to admit that something we have started has to be given up because of our own lack

of persistence. If we do give up under such circumstances, we usually find "good" excuses for it — like ill health or interference of other work.

The person who does not persist in his endeavors, who seems to have little "will power," may be one who does not weigh the pros and cons, who does not have any long-range goals, or for whom such goals have only a weak attraction.

#### Initiation of action

Under such conditions as extreme fatigue, alcoholism, low oxygen tension, low blood sugar, hypnosis, and brain injury, we may make decisions, yet be unable to carry them out.

An individual had several drinks and then felt that he should go home. He arrived there all right, but sat down in a chair and read for a while. He then said to himself, "I guess I'll go to bed now." But he did not go to bed. Two hours later he was still sitting and thinking about going to bed.

Investigators of high altitude flight have found that insufficient oxygen often produces a state like the above. Individuals who wait too long to take oxygen are unable to do so, although they are conscious and know what to do.

An inspector sat in a mine writing a last letter to his wife while he slowly approached asphyxiation from monoxide gas.<sup>34</sup> His letter did not make sense. It was incoherent and repetitive. But the important point for our purposes is that he knew perfectly well that, by walking twenty yards, he could avoid death. He had lost the power to initiate appropriate movements.

Related to the problem of "will power," therefore, is the problem of how, once we have chosen a course of action, we initiate the appropriate responses.

Reactions are customarily classified as *voluntary* (literally under the control of will) and *involuntary* (literally not under the control of will). Opening and closing my hand are called voluntary acts because I can control them myself. The contraction of my pupil, however, is involuntary. I have no control over it. It must be aroused by a stimulus which I myself cannot provide by thinking of, imagining, or intending its contraction.

The nervous pathways most directly involved in voluntary activity begin in the motor area of the cerebral cortex and terminate in the skeletal muscles (as discussed and illustrated in Chapter 13). It is therefore apparent that the neural events which initiate the voluntary movement must activate the cerebral end of these fibers. It is also apparent (from what we know about activities in the association neurons of the cortex) that these activities provide stimulation of the voluntary motor fibers. But what kind of associational activity necessarily precedes voluntary movement? This we do not know in any detail.

Introspective reports indicate that thinking or having an "idea" of a movement precedes voluntary arousal of the movement. We know that thinking of a movement, such as clenching the fist, automatically elicits slight movements of the muscles involved and also action currents which may be measured with a galvanometer.<sup>35</sup> The activities of association neurons which underlie thinking of the movement apparently serve to activate the cortical end of the motor pathways. Introspection also reveals that merely thinking of the movement does not produce it—all that occurs is a very slight, or an incipient, movement. If I want actually to clench my fist, I must *intend* to clench it. Here again, although we do not know the details, whatever cortical activities underlie intention apparently stimulate the motor paths which end in the appropriate muscles, and stimulate them in a somewhat different manner from that involved when we merely think of the movement.

We have already pointed out the important role which language, especially in the form of implicitly talking to ourselves, plays

in motivational activities. Language is especially important in the voluntary control of behavior. This conclusion is supported by general observations and experiments on the development of voluntary control. Individuals have learned to move their ears.<sup>36</sup> They have learned to move in isolation muscles of the body which are usually not subject to isolated control.<sup>37</sup> They have learned to make the hairs on the body rise "at will."<sup>38</sup> They have learned to contract the small blood vessels in the arm by thinking of a visual pattern or saying a word repeatedly associated with placing of the hand in icewater and thus, automatic constriction of blood vessels.<sup>39</sup> Not all the above obviously involved language, but they all involved either thinking or language responses. Thinking in man is partly a subvocal or implicit form of speech. The importance of linguistic activity in voluntary behavior is stressed in the following statement.<sup>40</sup>

The particular stimuli most significantly involved in the control of voluntary movement are those generated by the behavior of the organism itself. The kinesthetic, tactual, and auditory stimuli involved in language are the most important self-induced stimuli in man. By the aid of such receptor processes the organism becomes relatively independent of its external environment and can regulate its own behavior to an extent impossible in the infra-human animals. Behavior controlled by the organism's own language responses is voluntary in the highest degree.

More on the relation between thinking and language will be found in Chapters 12 and 15.

## Summary

Frustration, and associated psychological stress, has various sources — environmental obstacles, including other people who thwart us, our personal defects, and conflict situations. Among the latter, several basic types have been outlined. These are approach-approach, avoidance-avoidance, approach-avoidance, and

double approach-avoidance. Ambivalence is a form of approach-avoidance, but focussed upon the same person.

People differ in their ability to retain normal reactions when frustrated. Those who do not "go to pieces," those who can "take it," are said to have a high frustration tolerance.

Many people whose frustration tolerance is low lose their goal-orientation in times of stress. They do and say things which defeat rather than advance their aims. Aggressive behavior is often instigated by frustration.

When frustrated, one should maintain a problem-solving attitude, using all his resources to reach his goal or to force a resolution of conflicting alternatives. He should do this in the interest of his health as well as his happiness. Reference has been made in this connection to the general adaption syndrome (alarm reaction, resistance, exhaustion) associated with various forms of stress, including the psychological. The adrenal cortex seems to play a critical role in this "emergency reaction." It has been established that prolonged emotional conflict can produce ulcers and other psychosomatic disorders.

Associated with frustration are various compensatory or subterfuge reactions. Some of these resemble the form of physiological compensatory activity known as homeostasis. This is because their prime function is not so much to solve our problems as to cushion our ego (our feeling of self-esteem) against threatened deflation. Among such ego-defensive reactions are *fantasy* (including wish fulfilling dreams and daydreams), *projecting* (imputing one's thoughts and desires to others), *rationalizing* (finding "good" reasons for our actions or assuming a "sour-grapes" attitude), *repressing* (trying to ignore or forget the things that bother us), *regressing* (a reversion to childish ways), *identifying* (becoming ego-involved with other persons and situations), *blaming others* (excusing ourselves on the ground that others are responsible for our failures), *overcompensating* (doing more than is necessary to overcome defects, perhaps capitalizing on them), and

*sublimating* (getting indirect but socially acceptable satisfactions).

This does not exhaust the list of compensatory mechanisms, nor does it imply that those mentioned are non-overlapping. Blaming others, for example, may be considered a form of rationalization under certain circumstances, and it may represent a reversion to modes of reaction adopted in childhood (hence regression).

Abnormal reactions may be produced in animals by requiring them to make especially difficult discriminations and by forcing them to respond where previous training has inhibited the response now required. Extreme excitement, immobility, lethargy, regression, and other seemingly "neurotic" behavior often occurs under such circumstances.

"Will" and "will power" are inferred from behavior in conflict situations, especially the making of difficult decisions and the persistence of activity in a given direction despite obstructions and temptations to give up. Decision made under such circumstances may be interpreted as a resolution of conflicting alternatives. When decision is difficult to make, pros and cons are closely balanced. The effort involved in making the decision may be that of "weighing" the alternatives. Persistence can be interpreted similarly. The individual who persists in pursuing a long-range goal is perhaps one for whom this goal, in terms of his past experience, has a greater attraction than more immediate goals.

Language appears to play an important part in the initiating of action, once decisions to act have been reached. The cortical activities which mediate linguistic processes may initiate the impulses which, running from the motor cortex to the muscles, produce voluntary movement.

(References and notes for this chapter are on page 554 of the Appendix.)

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# Personality



The search for primary traits • Socially significant traits • The question of personality types • Personality and the endocrine glands • The assessment of personality • The development of personality • The normal personality • Psychoneurotic personalities • Psychotic personalities • Preventing personality disorders • Summary

The most distinctive feature of any individual is his personality. This is the overall pattern, or integration, of his structures, modes of behavior, interests, attitudes, intellectual abilities, aptitudes, and many other distinguishable characteristics. Thus the term *personality* refers to the whole individual. Viewing a person as he goes about the various activities of his everyday life, we usually obtain a total impression of his personality as “agreeable,” “disagreeable,” “dominating,” “submissive,” or the like. Scientific psychology, however, views the individual more analytically. Little can be done scientifically with an overall impression. Thus, if the person comes into a psychological clinic for advice, or if he takes part in a psychological experiment on personality, his behavior may be observed in various situations, he may be interviewed, and he may be given tests designed, as it were, to “dissect” his personality into its components. These components are referred to as personality *traits*. Personality tests are designed to reveal and measure them. Intelligence, although we have not discussed it from this angle, is a personality trait. Interests are personality traits. So, also, are aptitudes. In addition, there are numerous other personality traits. All are aspects of the individual which, while we isolate them for study and measurement, are actually interwoven with every other aspect of personality.

Some aspects of personality are rather evident — for instance, friendliness, general vigor, calmness in emergencies, and sociability. Psychologists often refer to such clearly evident aspects as *surface traits*. These are the traits measured most readily with rating scales, questionnaires, and pencil-and-paper tests of personality. But psychologists are also interested in the “inner personality,” consisting of so-called “depth factors.” These include fears and anxieties, concepts relating to the self, and desires and aspirations. The person may be aware of these and, if so, he can reveal them in interviews. On the other hand, he may not be aware of them. In this event, we refer to these aspects of personality as *unconscious*. Earlier discussions (p. 18) revealed that psychoanalysts study the “depths” of personality through free association and the analysis of dreams. Special tests have also been devised to probe these inner aspects of personality. Some tests of this nature will be described presently.

### THE SEARCH FOR PRIMARY TRAITS

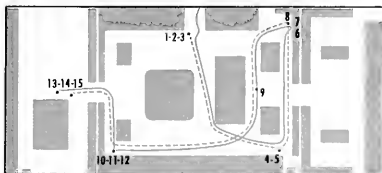
While we are speaking of surface and depth traits, the reader may well ask, “How many really different traits are there?” This is comparable to asking, “How many different facets, aspects, or dimensions does a personality have?” It is also equivalent to asking, “How many separate terms do we need in order to describe a personality completely?” Actually we do not know how to answer this question.

Earlier discussions dealing with the factor analysis of intelligence and aptitudes gave the reader some familiarity with the problem of discovering primary factors. It is only through a similar statistical approach that we can hope to discover the primary, or irreducible, aspects of personality. However, personality is so complex that the task of finding primary components appears, at first glance, to be insuperable. As a preliminary approach we may catalogue all of the personality adjectives used in literature and in everyday life. Two investigators<sup>1</sup> studied dictionaries and found eighteen thousand terms referring to personality. However, many of these mean the same thing or nearly so. Take, for instance, the terms: *anxious*, *fearful*, *apprehensive*, *troubled*, *solicitous*, and *worried*. The appearance of many such words, all having a somewhat comparable meaning, suggests that one word may be sufficient to describe this aspect of personality. The term *anxious* might well serve our purpose. Analysis along these lines leaves us with such key terms as *anxious*, *sociable*, *introspective*, *depressed*, *neurotic*, and so on. We may then develop tests designed to measure the aspects of be-

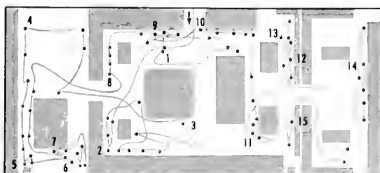
havior represented by these. When tests designed to measure many apparently different aspects of personality have been devised and administered to large groups of individuals, test scores may be intercorrelated. Then, if it is found that tests designed to measure anxiety are highly correlated with those designed to measure neuroticism let us say, the question arises as to whether we are really measuring two traits. Perhaps *neuroticism* alone, *anxiety* alone, or some new term is all we need and perhaps one test will suffice. In this general way, the number of “traits” may be narrowed down. One very extensive factor analysis of personality tests revealed that the results could be accounted for if there were only twelve different traits.<sup>2</sup> Another study revealed only seven. These were: general activity or drive, masculinity-femininity, impulsiveness, dominance-submission, emotional stability, sociability, and reflectiveness.<sup>3</sup> Still another, beginning with tests of what was supposed to be a unitary trait found statistical evidence for subsidiary factors.<sup>4</sup> Obviously it is too early in the game to present a definitive list of personality traits. Perhaps we may look to the day, however, when the writer of a book like this can say, “These are the primary components of personality and here are the tests which provide a measure of each.” In the meantime we will not concern ourselves further with the problem of how many really different personality traits there are.

### SOCIALLY SIGNIFICANT TRAITS

It is rather obvious that certain aspects of the individual, and especially those having



A



B

**9.1 Different Behavior of an Introverted and an Extraverted Child in a Museum Situation.** A. The path of an extremely introverted child. The child refused to move without the experimenter, whose path is represented by the broken blue line. Black dots indicate stops. Gray areas represent exhibits. The figures show the subject's position at the end of each minute. B. The path through the museum of an extremely extraverted child. The long distances traveled and the stops are characteristic of the extravert. (From Marston.)

social significance, contribute more weight than others to his personality as others see it. From the standpoint of how others regard him, for example, his intelligence and his scholastic aptitude may be overshadowed by such social considerations as how well he gets along with others, how susceptible he is to irritation because of what people do and say, how he dresses, his manners, and how closely his behavior conforms with what is generally conceded to be moral and good.

The last-mentioned feature is the basis for speaking of *character*, which is personality viewed from the standpoint of the ethical or the moral. The most enduring characteristics which have social and ethical significance are often referred to as "character traits," to distinguish them from "characteristics of no particular social or ethical significance." Honesty would thus be a "character trait," and emotionality a "personality trait," not further differentiated as in the case of honesty.

The aspect of the personality picture that predominates is always the *social* aspect. Those who say, quite incorrectly of course, that someone "has no personality" are saying, in reality, that they do not like him, or that they are indifferent to him. When they say, on the other hand, that someone "sure has a personality!" they are actually saying that they like him—that they are attracted to him rather than repelled or left indifferent. Popular terms like "sex appeal" further illustrate the point that, whatever personality may be in cold abstract scientific terms, to others it means the social self; the role played in social relations. Indeed the term *personality* was

probably derived from the mask (*persona*) which actors wore in ancient times to show the audience whether they played the villain's or hero's role in a drama.

#### THE QUESTION OF PERSONALITY TYPES

It has been a favorite practice of human beings, including certain psychologists, to type their fellow men. In the drama, as suggested above, there are the heroes and villains. In comics, movies, and TV there are likewise "good guys" and "bad guys."

When psychologists type their fellow men, they usually seek statistical justification (see p. 60) and they use a technical terminology.

##### Introversiion-extraversion

One of the most widely used psychological typologies, that of the psychiatrist Carl Jung, refers to individuals as *introverts* or *extraverts*.<sup>5</sup> The former is pictured by Jung as reacting negatively to situations or as tending to withdraw from them. The introvert is also characterized as inwardly reflective. The extravert, on the other hand, reacts positively. He is outwardly expressive, tending to be talkative and active in making social contacts.

We have many tests designed to measure introversiion-extraversion. Some are behavior tests. One such test involves taking children into a museum and seeing how each reacts.<sup>6</sup> The path followed in going from one exhibit to another is traced and the time spent at each exhibit is recorded. Note, for example, the two patterns in Figure 9.1. The child

rated as an introvert moved slowly, kept at the side of the adult most of the time, and did not return to any of the exhibits. But the child rated as extravert showed a great deal of spontaneous interest in the exhibits, moved rapidly from one to another, went back to look again, and of course covered much more territory.

Most introversion-extraversion tests are for adults. These are verbal in nature. In taking one such test, the examinee checks or leaves unchecked statements like: *I daydream a lot*, *I would rather read than play games*, and *I like to speak in public*. Endorsement of the first two statements is rated as introvert; of the last, as extravert.

Another type of verbal test requires the subject to check one out of each set of items like the following:<sup>7</sup>

How do you prefer spending your odd moments?

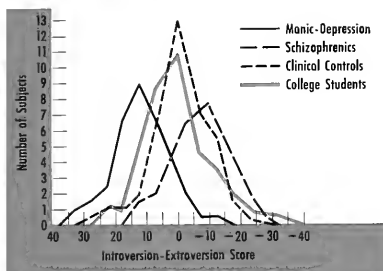
— Always spend odd moments reading and planning

— Prefer to spend odd moments reading and planning  
 — Time equally divided between reading and physical activity  
 — Prefer to spend odd moments in physical activity  
 — Practically all odd moments spent in games and sports

Here the first statement is most introverted and the last most extraverted, with gradations between. This suggests, quite properly, that introversion-extraversion is a continuum and not a dichotomy.

What do such tests tell us about types? In an unselected group of people and even in a group of college students, we generally find something approximating a normal distribution. Most individuals, as shown in Figure 9.2, are in the middle. This is because their introvert answers are balanced by extravert answers. We call these *ambiverts*.

There is thus no justification for saying that everyone is either an introvert or an extravert. In psychology we use these terms only to represent persons at the extremes of the distribution. However, as Figure 9.2 indicates, it is possible to select groups which will give predominantly introvert or extravert reactions. Among the mentally ill, those with schizophrenia (see p. 263) tend to be introverted while those with manic-depressive psychosis (p. 262) tend to be extraverted.<sup>8</sup> This does not mean, however, that introverts are inclined to be schizophrenic and extraverts manic-depressive. Look again at the figure and note that some normal people are as introverted as schizophrenics — and some as extraverted as manic-depressives. Some of our greatest thinkers and research scientists are decidedly introverted while some of our outstanding politicians are just as decidedly extraverted. However, the usual and most desirable tendency is ambiversion.



**9.2 Distributions Based on an Introversion-Extraversion Test.** On this test, 35 manic-depressives, 35 schizophrenics, 44 mentally normal clinic patients, and 44 medical students were distributed as shown. The positive scores are in the extravert direction. Note that manic depressives were more extraverted, as a group, than schizophrenics, but that many in each group fell into the ambivert range. Normal subjects, however, had predominantly ambivert scores. Manic-depressive psychoses and schizophrenia are discussed later in this chapter (pp. 262–266). (From Neymann, C. A., and G. K. Yacorzynski, 8.)

### Physique and temperament

There is a widely held belief that human beings can be classified into physical types. Going with this is also the idea that somehow one's physique determines his *temperament*, a general term used to represent such emotionally toned aspects of personality as joviality, moodiness, tenseness, and activity

level. Shakespeare expressed a belief in the correlation between personality and body build when he had Caesar say

Let me have men about me that are fat;  
Sleek-headed men, and such as sleep o' nights.  
Yon Cassius has a lean and hungry look;  
He thinks too much: such men are dangerous.  
*Julius Caesar*, Act 1, scene 2

*Physique.* Differences in physique are obvious. Everybody knows a fat person, a person who is bulging with muscle, and a person who is extremely thin. But he also knows many people who cannot be fitted into these categories. Such nondescript physiques provide the main stumbling block for those who attempt to type human beings in terms of body build.

Proving that people can be typed with respect to physique is one problem. Still another problem is to show that personality, the uniqueness of which, in each individual, has already been mentioned, can be typed. If bodily types and personality types are found, one may then investigate the possibility that variations in body type and in personality type are actually correlated.

Kretschmer in his *Physique and Character*, claimed that there are three main types: the *pyknic* (short and fat); the *athletic* (muscular); and the *asthenic* or *leptosomic* (tall and thin). The *pyknic* type was credited with such personality traits as extraversion; the athletic with energy and aggressiveness; and the *asthenic* with a tendency toward introversion. It soon became apparent, however, that people do not, by and large, divide up into these categories. Moreover, even those who do fit the stereotype of a *pyknic* do not necessarily fit the personality type alleged to go with this physique. In one study, for example, 50 per cent of the *pyknics* were rated as extraverts while 30 per cent were rated as introverts.<sup>9</sup>

The most recent and by far the most ambitious, attempt to discover a possible relation between physique and personality is that of Sheldon, which substitutes quantitative ratings of both the bodily and psychological characteristics for the general impressions used by earlier writers.<sup>10</sup>

Hundreds of young men were photo-

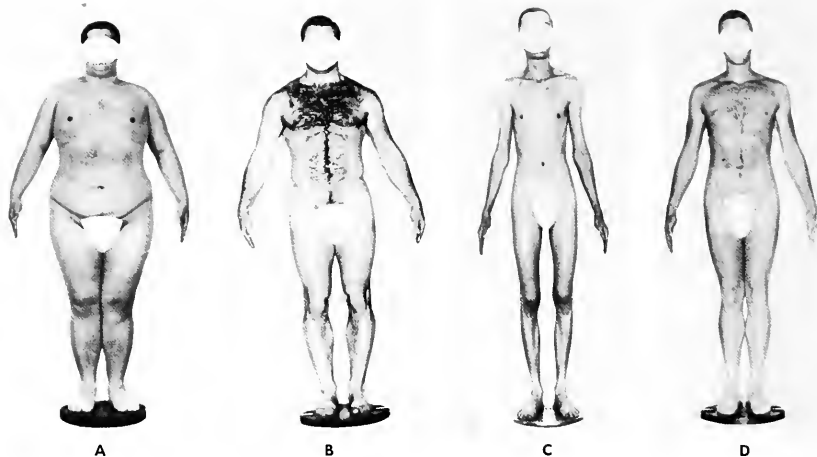
graphed from three different positions while naked. The thousands of photographs thus obtained were then arranged and rearranged in various series to see whether any types could be discerned. No clear-cut types were evident, but there were characteristics possessed in *varying degrees* by all individuals. Some had a very predominant abdominal region, some no predominance of this region at all, and others some degree of abdominal prominence between these extremes. This *dimension* of physique was designated *endomorphism*, the name being suggested by the fact that our digestive viscera develop largely from the endoderm of the embryo. Individuals could also be arranged in a series with respect to muscle, some being extremely muscular and others not. Since muscle comes primarily from the mesoderm of the embryo, this dimension was referred to as *mesomorphism*. One other dimension was evident, that having to do with a thin body; relative prominence of skin and neural structure. This was called *ectomorphism*, suggested by the ectodermal origin of skin and nervous system.\*

Within each of these dimensions one may be rated on a scale of from 1-7 (Figure 9.3). Thus a person with predominant endomorphy may be rated 7-1-1. He has the highest rating for endomorphy and the lowest rating for mesomorphy and ectomorphy. The person somatotyped as 1-7-1 has the maximum degree of mesomorphy and the lowest degree of both endomorphy and ectomorphy. The somatotype 1-1-7, on the other hand, represents a predominance of ectomorphy. The 4-4-4 individual is about average with respect to each dimension.

It has doubtless already become apparent to the reader that those people with a predominance of endomorphy are the *pyknics*; those with a predominance of mesomorphy, the *athletics*; and those with a predominance of ectomorphy, the *asthenics* of the earlier classification.

*Temperament.* The next step in this research was to devise a method of rating the subjects for temperament. Hundreds of terms describing aspects of temperament were

\* A British investigator refers to these dimensions as, respectively, *fat*, *muscular*, and *linear*. See Parnell, R. W., *Behavior and Physique*. Williams & Wilkins, 1958.



**9.3 Predominant Endomorphy, Mesomorphy, and Ectomorphy Compared With an Average Physique.** The somatotype is given in terms of degree of endomorphy, mesomorphy, and ectomorphy, each number representing the respective degree of each. The predominant endomorph represented in **A** is somatyped 7-3-1, meaning a maximum degree of endomorphy, a lower than average degree of mesomorphy, and a minimal degree of ectomorphy. The predominant mesomorph **B** has the somatotype 1 1/2-7-1; the predominant ectomorph **C** the somatotype 1-1-7 and the average individual **D** the somatotype 4-4-4. (From Sheldon, W. H., and S. S. Stevens, 10.)

selected and finally reduced to fifty. A group of college students was then rated for each of the traits represented—traits like relaxation in posture and movement, love of physical exertion, directness of manner, and so forth. Statistical analysis suggested that the apparently separate traits fell into three groupings, with the items within each group being closely related. One of these groupings, or “dimensions” of temperament, was designated *viscerotonia* because the many related items had some reference to visceral comforts, such as joy of eating, joviality, and relaxation. Another dimension was given the name *somatotonia* because the relevant items involved bodily (somatic) activity, as in competitiveness, energetic movement, and aggressiveness. The other dimension, *cerebrotonia*, was so named because the various related traits suggested a dominance of cerebral processes, as in apprehensiveness, restraint, shyness, and hypersensitivity.

The investigators found that it was feasible to represent the dimensions of temperament, as in the case of physique, on a seven-point rating scale. Thus a person with extreme viscerotonia might be rated 7-1-1; one with extreme somatotonia, 1-7-1; and one with extreme cerebrotonia, 1-1-7. Case studies filled out the impressions gained from ratings. A student rated 6-3-2 for temperament had, among many other aspects, “a *persona* of joviality.” Another rated 2-7-1 could be characterized as “boiling over with energy.” Still another, rated 1-3-7, was characteristically “tense and apprehensive.” There were of course individuals who rated as intermediate in all three dimensions.

*Correlation between physique and temperament.* Separate ratings of 200 male college students for physique and temperament yielded *r*'s in the neighborhood of .80. This high correlation is not surprising in view of the fact that (1) the same investigators did

both ratings, (2) there was a tripartite classification of both physique and temperament, and (3) both sets of ratings were on a seven-point scale. Indeed the investigators admit a possible bias, but feel that this is not responsible for the correlations obtained.

Critics of the view that this research has revealed a significant correlation between physique and temperament emphasize the bias inevitably involved. What is needed is independent somatotyping and temperament typing; the latter with tests devised by others than those who did the somatotyping. The same persons should not do both the rating of physique and rating of temperament. Until bias is eliminated in some such fashion, there are grounds for skepticism.

A study carried on at a boys' academy showed no relations between the Sheldon somatotypes and various measures of personality.<sup>11</sup> On the other hand, another independent study on college students showed that, out of fifty predominantly ectomorphic students forty-two were rated predominantly cerebrotonic, one somatonic, one viscerotonic, and six without dominance of any of the three posited dimensions of temperament.<sup>12</sup> Only in the extreme of a dimension, however, could one expect such a relationship to show up so clearly.

There are some doubts concerning the generality of Sheldon's data. He utilized well-fed American college students. But a study on human semistarvation (see p. 144) revealed that somatotypes vary with nutrition. All subjects eventually approached or reached an ectomorphic physique. The investigators concluded, in fact, that "the technique of somatotyping would appear to be more useful for determining the state of nutrition than for determining the inherent constitution."<sup>13</sup> Another doubt comes from England, where Oxford University students were somatotyped. Unlike Sheldon's Harvard group, most of the Oxford students had average physiques. Extreme mesomorphs were absent—men with "proportionately large bone and muscle development"—and also men with "a high proportion of fat and comparatively little musculature." The predominant tendency was toward "central somatotypes with more evenly balanced physiques."<sup>14</sup> People outside of universities, and especially people in

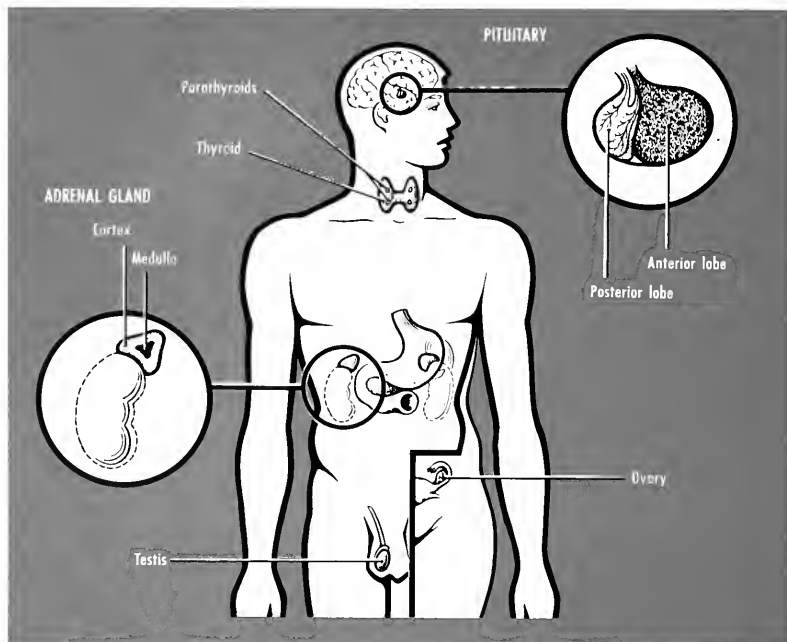
middle or late life, might well differ from those already somatotyped. Thus, although somatotyping is an interesting approach to the age-old belief that there is an important relation between physique and temperament, much remains to be done before the overall significance of the results can be assessed.

Should a significant relationship between physique and temperament be established beyond question, one might then ask why there is such a correlation. We should not, on the basis of this correlation, be justified in concluding that physique determines temperament, or vice versa. Both might depend to a large degree upon glandular functioning. It is possible, too, that temperament is influenced by how other people react to our physical characteristics. If they avoid us, or cause us to suffer indignities because of our physique, we may respond by becoming aggressive, or, on the contrary, by "crawling into our shell." If they lionize us because of our fine physique or our handsome appearance, we may act like the "cock of the walk." We may become conceited, domineering, or merely patronizing. Thus the significance of our physical makeup, from the standpoint of personality, cannot be considered apart from its social impact and how the person himself reacts to this. A person's physique is to him the "image of himself."<sup>15</sup> Thus the predominant endomorph may learn that he is expected to be jovial and he may look upon himself as a jovial person.

#### PERSONALITY AND THE ENDOCRINE GLANDS

The chief endocrine glands are pictured in Figure 9-4. Only four of them—the pituitary, the thyroid, the adrenals, and the gonads—have any known direct relation to aspects of personality.

Earlier discussions of the endocrine glands dealt especially with the influence of the gonads on sexual motivation (p. 145) and with the influence of the thyroid gland in relation to intellectual growth (p. 99). These, together with the pituitary and adrenal glands, also influence physique and temperament. In fact, the alleged correlation between physique and temperament described above could result from the concurrent effect of the endocrine glands upon both aspects of personality.



**9.4 Some Endocrine Glands of Special Importance for Personality.** The pituitary gland (located at the base of the brain,) has two lobes, anterior and posterior, as illustrated. It is the anterior lobe which secretes ACTH. Our parathyroid glands (not discussed in the text), are embedded in the thyroid gland. They are concerned with calcium metabolism. Note that the adrenal gland (above the kidney) has an inner structure (medulla) and an outer layer (cortex). The medulla secretes adrenalin; the cortex, cortisone.

You will recall that the endocrines pour their secretions (hormones) directly into the blood stream, which carries these to every part of the body. As one endocrinologist said, "We are terribly at the mercy of our endocrine glands." Unless these produce the needed hormones, our whole bodily economy is disturbed and marked changes in appearance, physique, temperament, and intelligence may result. Such changes may also have social reverberations, leading us to repel rather than attract others or to be objects of amusement or curiosity like the dwarf, the giant, and the bearded lady of the circus.

The endocrines comprise what is, in effect, an interlocking system. Disturbing the functioning of one gland may lead to the malfunctioning of other glands.

A gland of special importance from the above standpoint is the *pituitary*, a small structure below the brain stem. This gland has two lobes, an *anterior* and a *posterior* one. The posterior lobe has no known relation to personality. The anterior lobe, on the other hand, secretes several hormones, including growth hormones which have much to do with the determination of physique, and, through their effect on the gonads,



with the nature of sexual development. The dwarf that you see at the circus may have an underactive and the giant an overactive anterior pituitary gland. An undersexed male may also have an underactive anterior pituitary, the underactivity in this case being represented by an insufficiency of the pituitary's gonad-stimulating hormone.

Another hormone from the anterior pituitary is known as the adrenocorticotrophic hormone, or ACTH. As its long name suggests, this hormone stimulates the adrenal cortex. The *adrenal* gland (see Figure 9.4) has a core (medulla) which secretes nor-adrenalin and adrenalin. The latter is secreted in excess during emotion and has general bodily reverberations which gives us the excess energy needed in emergencies. We had reference to nor-adrenalin and adrenalin in discussing emotion (p. 186). The outer covering, or *adrenal cortex* is of more interest to us in the present connection. When activated by ACTH, this secretes cortisone, a hormone necessary for life. If the pituitary is defective and fails to produce ACTH, the latter can be given by injection. Sometimes ACTH is secreted, but the adrenal cortex itself is defective. In this event, the condition may be corrected, and the person's life saved, by administering cortone, a synthesized cortisone. When there is inadequate cortisone for whatever reason, the individual undergoes a marked change in personality; he becomes weak and lethargic, loses his sexual desire and appetite for food, and suffers a widespread breakdown of physiological functions, including salt metabolism. During regular administration of cortone, however, there is a restoration of general vigor and of other functions.

Overactivity of the adrenal cortex in early life may produce puberty praecox, illustrated in Figure 9.5. There are several such cases on record, including some of little girls with the secondary sex characteristics of mature women.<sup>16</sup> Excess secretion of the adrenal cortex can also produce extremely masculine characteristics in women, such as those represented by the bearded lady.

We have seen that the sexual aspects of personality are influenced by the gonads, the anterior pituitary, and the adrenal cortex. General vigor is affected by these glands and also by the *thyroid*. We have already

learned that an insufficiency of the thyroid hormone (thyroxin) produces cretinism, involving a low order of intelligence. Underactivity of this gland later in life produces lethargy. Overactivity may produce so-called "nervous tension." The former condition may be corrected by use of thyroxin;



**9.5 A Boy with Puberty Praecox.** The child's chronological age is six years and one month and his mental age six years. Sexual development is equivalent to that of an adolescent. (Photo by Norman C. Hovger.)

the latter by reducing the secretion of thyroxin through surgery or radium treatment.

Perhaps a word of caution about endocrine functions is in order. Although an underactive thyroid tends to produce lethargy, one must not jump to the conclusion that every lethargic person has an underactive thyroid. Nor should we conclude that any obviously nervous individual has an overactive thyroid. Likewise, even the most frigid person sexually as well as the most sexually driven may have normal gonads. In other words, while specific glandular malfunction may produce certain changes in personality, similar changes are often produced by other conditions — disturbance of other glands, malnutrition, and attitudes and habits acquired in the course of development. Diagnosis of glandular malfunctions must come from the clinical tests of the medical laboratory.

### THE ASSESSMENT OF PERSONALITY

Many situations in everyday life require personality assessment. In business and industry it is often very important to know certain things about the personality of a prospective employee. The armed services select men for important positions in terms of their personality. During the last war the Office of Strategic Services (OSS) carried out an elaborate assessment program. It was designed to select personnel for such strategic services as gathering information behind enemy lines, organizing and training resistance groups, and disintegrating the morale of enemy troops. Educational institutions sometimes screen candidates for scholarships from the standpoint of personality as well as scholastic ability. The maladjusted child or adult is given personality tests designed to diagnose the nature of his difficulties. In mental hospitals and psychiatric clinics such tests are used not only to diagnose personality disorders but also to measure improvements resulting from psychotherapy.

Personality tests are also used in research. Here they aid in answering such questions as: How does personality change with age? Do *only* children have personality traits which distinguish them from other children? Do identical twins differ in personality? How are personality traits related to socio-economic status? What is the effect upon personality

of growing up in a fatherless home? In order to answer such questions, the investigator must have at his disposal procedures for measuring personality.

The person who undertakes to assess personality, either for practical or scientific ends, has a difficult task before him. He has no foreknowledge of what we are and how we got to be what we are. Like the detective attempting to unravel a mystery, he comes in at the end. As he observes us, he finds that he can describe various aspects of our personality but that other aspects, including our motives, are obscure. To reveal these aspects he needs more than general impressions. Sometimes, as suggested in our discussion of clinical psychology (pp. 32-33), the psychologist obtains a case history. This at its best reveals the developmental history of the personality to be assessed, the nature of his adjustment problems, and the involvement of other people in these problems. An interview with the person provides additional information. But a case history and an interview are often insufficient. The individual must be observed in various situations and it may be necessary to have his behavior rated by others as well as by the investigator himself. In many instances it is also necessary to use questionnaires and a variety of standardized personality tests.

There are three general approaches to personality assessment. One of these might be called a *holistic*, or overall approach. Emphasis is placed upon evaluating the person as a whole. An answer is sought to the question: What sort of *person* is this? The holistic approach was first used by German military psychologists, then by British army psychologists, before it was adopted by the Office of Strategic Services (OSS) in this country to select undercover agents and other strategic personnel. A second approach, which also aims to assess the whole person, but which does it less directly and with more restricted testing situations than the one already mentioned, is the *projective test* approach. The third approach, by contrast with the other two, is somewhat piecemeal. It goes upon the assumption that personality is a constellation of traits and that the traits may be measured separately. This might well be called the *trait* approach.

As we pointed out at the beginning of this

chapter, the trait approach has given rise to many tests designed to measure various aspects of personality, like introversion-extra-version. It is also behind the search for so-called "primary factors" in personality.

These three approaches are of course not mutually exclusive. Even the assessment staff of the OSS made some use of projective tests and also of tests designed to measure traits. The following discussion is arranged to indicate the nature of these three approaches and the sort of information revealed by each.

### HOLISTIC ASSESSMENT

There is no one holistic procedure. Although they were aiming at overall assessment, the German, British and American examiners used somewhat different procedures. For purposes of illustration we have taken the procedure used by the assessment staff of the OSS.<sup>17</sup>

The staff of the OSS included psychiatrists, psychologists, and army administrators. Candidates lived with the staff in a single establishment designated as S. They arrived in groups and stayed for three days. Before arrival, each candidate was deprived of all means by which his test-mates could identify his civilian or service origins or status. He was given a fictitious name and told to create a cover story which would effectively hide his identity. Later, in a stress interview, he was grilled in an effort to make him break down and reveal his true identity.

Members of the staff began their appraisal as soon as a candidate stepped off the truck which brought him to S. How he greeted the staff, the position he took with respect to his fellows (whether he followed or led) and how he reacted to the strange situation, were all noted. Even his conversation was observed, to discover what it revealed about his attitudes, prejudices, ideology, faith, and purposes. After dinner, some stood aside while others engaged in conversation. This, too, was noted.

All were eventually given written tests and questionnaires. These were designed to reveal aspects of personality, as well as biographical information of possible value in interviews to follow.

The assessment program involved several

behavior tests, of which the "brook test" is representative. This was designed to test group participation in problem solving and to reveal "natural leaders." In groups of from four to seven, the men were taken to a brook which was to be regarded as a raging torrent, so fast and so deep that nothing could be rested on the bottom. Their job was to transport certain camouflaged equipment to the other side and to return with other camouflaged material. There were restrictions which made this a difficult problem. In order to solve it, the men would need to cooperate effectively in building a bridge, an overhead cable, and other devices with the materials made available. No leader was designated. In this situation the observers looked for possible emergence of a leader, for shifting of leadership, and for such characteristics of the men as energy, initiative, relevant ideas, willingness to work with others, good nature when ineffective ideas were rejected, and so forth.

An important role in assessment was played by *interviews*. The investigators say that "No procedure yet devised by psychologists for the study of personality can take the place of the clinical interview. . . . it contributed more heavily than any other procedure to the final rating of all personality variables. It provided the frame of reference in which all other observations were evaluated. From it came a large measure of the understanding of the person. . . ." <sup>18</sup> The interviewers had at their disposal all of the biographical and other data concerning the candidate and they guided the interview in terms of the kind of information needed.

Another type of test, called the *stress interview*, was designed to discover the candidate's "capacity to tolerate severe emotional and intellectual strain." He was given a few minutes to invent a cover story, then taken before a panel of interviewers. Here he was subjected to "strain created by rapid merciless cross-questioning under disagreeable conditions." The ostensible aim was to detect flaws in his cover story. Questions were at first asked in a quiet conciliatory manner. Then, as some flaw was detected, an examiner yelled, "You're a liar." He would try to turn the candidate's story in such a way as to get him to admit a lie, then he would yell, "Now we have the truth, you admit that you lied." Tension was built

up throughout the interview, so that at the end the questions were hurled at the candidate in rapid fire staccato succession. The subject was not at any time allowed to relax. He sat straight up. If he crossed his legs he was told to uncross them. If he lowered his head to avoid the light, he was told to look up. After ten minutes of stress, the individual was told "We have abundant evidence that you have not been telling the truth. That is all."<sup>19</sup>

During the interview the candidates were rated for degree of emotional control. They were observed closely to detect signs of sweating, flushing, swallowing, moistening the lips, stuttering, and so forth. Sometimes a candidate exploded with anger. Sometimes he wept. Sometimes he protested. Immediately after this stress interview, each candidate was given another interview under relaxed conditions. Here further efforts were made to get him to relax his guard and reveal secret information. The various responses of the candidates under these circumstances "gave excellent insight into their security consciousness as well as into their intellectual resourcefulness and emotional stability."<sup>20</sup>

Near the end of the assessment period, after many written and behavior tests had been given, many questionnaires had been filled out, and several interviews had been conducted, the men were given a *sociometric questionnaire*. This was to discover how a particular man was *accepted* by others of the group, to reveal the men whom others *rejected*, to indicate how the person filling out the questionnaire *reacted to others*, and, in general, to reveal *leadership*, or the lack of it. The questionnaire included items like these: "With whom would you enjoy continuing your acquaintance?," "Which men seemed to antagonize other members of the group?," and "Whom would you recommend as supervisor of a group dealing with problems of planning and organization?"

The overall assessment pooled all available information and represented the combined estimate of various interviewers and other assessors.

Holistic assessment obviously reveals a great deal about a person. But it is still in its infancy and psychologists have yet to prove that it is sufficiently superior to other methods

to justify the large personnel, expense, and time involved. It was impossible, even for the OSS Staff, to discover the correlation between their estimates and actual performances in the theatres of war. This was in part due to the uniqueness of the OSS assignments themselves and to the unpredictability of conditions under which each agent worked. The many psychiatrists and psychologists who collaborated on this project concluded, however, that their type of approach can be developed into "an extraordinary instrument for accomplishing three important purposes simultaneously: (1) the selection of the most suitable persons for important jobs; (2) the advancement of our understanding of personality; and (3) the adequate training of clinical psychologists and psychiatrists."<sup>21</sup>

A somewhat comparable approach to personality assessment was used with Veteran's Administration trainees in Clinical Psychology.<sup>22</sup> Here again difficulty was experienced, at the time, in evaluating test results with respect to later accomplishments. Nevertheless, a follow-up study 10 years later showed very little correlation of test results with performance at this time (1957).<sup>23</sup>

## PROJECTIVE TESTS

Projection is said to be evident whenever we attribute our own motives to others, or even to inanimate objects. Projective tests are so named because they induce the individual to project — to put himself into the test situation, or to identify with the persons therein and, by telling about them, to reveal his own motives, attitudes, apprehensions and aspirations.

There are many projective tests — sentence completion, doll play, perception of inkblots, interpretation of pictures, and so forth. Despite their apparent differences, all such tests have two features in common.

In the first place, they present the person with a relatively *nonstructured situation*. That is to say, they involve a situation, which, instead of calling for a stereotyped and predictable reaction from one person to another, may elicit many different reactions, depending upon the individual being tested. Take, for example, the incomplete sentence "All men are born free and . . ." This is structured. It

brings forth but one completion from most, the word "equal." This tells us nothing about the individual except that he has been indoctrinated in a certain way. But take the sentence, "The main driving force in life is . . ." One person may complete the sentence with "to achieve security," another with "to achieve happiness," and still another, with "sex." The item may be completed in many different ways.

In the second place, projective tests all have in common the fact that they *catch the subject off guard*. They are designed to "entice the subject into revealing himself without his being aware of the fact that he is doing so."<sup>24</sup> This is especially evident when, instead of telling about themselves, their home life, and their reactions to their parents, children are induced to play-act with dolls dressed like grownups and children. At first the child arranges the furniture and persons in more or less stereotyped ways, "But suddenly the observer realizes there has been a change, not a quick or easily detectable one, but one that has taken several minutes and has just now reached the observer's threshold. The child is more intent on the dolls, less reactive to the observer, and he is living strangely in this new fantasy world. He begins to tell stories that have no immediate parallel in his real life; he makes the family people behave as family people virtually never do. There are fantastic punishments and catastrophic accidents, social roles are reversed, and a few routines like toileting may exclude all the rest of ordinary everyday activity . . . and then the observer has a feeling that blinds have gone up, and he is seeing the inner person of this child. It is as if the child were making him see this family world as the child himself sees it — or, perhaps as he would like to see it."<sup>25</sup> The same sort of naïveté is present, although less obviously, when adults interpret inkblots and tell stories based upon nonstructured picture situations.

The most widely used projective tests at the adult level are the Rorschach inkblots and sets of pictures for which the subject is to invent themes. These tests, or variations of them, are also widely used to study personality in children. The Rorschach test has, in addition, been used to study changes in personality associated with old age. It has also



## 9.6 An Inkblot and What Four Subjects Saw in it.

"It is two cat-like creatures sticking out their tongues at each other. They appear to be joined together like Siamese twins. The small objects are apparently kidneys. The elongated object at the bottom could be a table leg."

"It is a flower opening up, or two heads facing each other."

"There are two old ladies up a tree and facing each other. Perhaps it is a diving mosquito."

"It is the spine surrounded by internal organs, with the lungs shown in white at the top. The two objects at the side are kidneys."

been used by anthropologists in studying primitive peoples.

### The Rorschach test

This test utilizes ten standard inkblots. An ink blot made in the same manner as those in the Rorschach Test is reproduced in Figure 9.6. Some of the Rorschach ink blots are, however, colored. The subject is shown the ten ink blots, one at a time, in a standardized order and position. He is asked, "What could that be?" or, "What do you see?" The subject is allowed to turn the blot and look at it from different positions. Different people, of course, "see" different things. Responses are scored in terms of the total number of items seen, whether the items involve the whole ink blot or only parts, qualities perceived (color, form, movement), and the kinds of things reported (like anatomical parts, animals, plants, people, and so on).

Scoring of Rorschach data is becoming fairly well standardized, but the interpretation of the scores is far from standard. Most Rorschach testers maintain that interpretation is necessarily subjective — that it calls for experience, ingenuity, insight, and common sense.

Rorschach testers have reported considerable success in differentiating normal and psychotic individuals, and in distinguishing between different kinds of psychotics, in terms of Rorschach findings alone.<sup>26</sup> Nevertheless, many psychologists are not fully convinced of the scientific validity of some of the assertions made by Rorschach testers. They want more experimental evidence in support of such claims.<sup>27</sup>

### Thematic apperception

When we perceive a situation in terms of past experience instead of responding merely to what is physically before us, we are ap-

**9.7** Administering the T.A.T. The subject is telling a story to go with one of the pictures of the T.A.T. series. (Photo by Howard Modovis, Life, © Time, Inc.)



perceiving. Since our past experiences are different, we get different meanings from what is, photographically, the same for all of us. Indeed the assumption underlying the Thematic Apperception Test (T.A.T.) and others like it is that the meaning which we get out of, or inject into, a pictured situation reveals something of our past experience and the motives derived from it.

The subject is shown a standard series of pictures (Figure 9.7) in a definite sequence and is asked to make up a story for which each picture may serve as an illustration. The tester says "Tell me what events have led up to the present occurrence, what the character (or characters) in the picture is (are) thinking and feeling, and what the outcome will be."<sup>28</sup> After the subject has told a story for each picture, his themes are analyzed in an effort to discover his "motivational structure." The themes are assumed to be projections of the subject's "innermost fantasies." It is not unusual for one theme to recur again and again as the individual goes from one picture to another. The recurrent theme may involve such things as death, mother love, and need for affection.

The criticisms of the T.A.T. are basically those already mentioned in connection with the Rorschach test. Although themes are easily identified, their interpretation has not yet been put on the quantitative basis which scientific procedure demands. Even so, the test has had value in suggesting hypotheses about individual motivation. These hypotheses, as suggested above, may be evaluated in terms of other test results and biographical information. Indeed it is customary in clinical work to use several tests and to pool all available information before reaching a final conclusion about the personality structure of an individual, or the nature of his adjustment problems.

### MEASURING PERSONALITY TRAITS

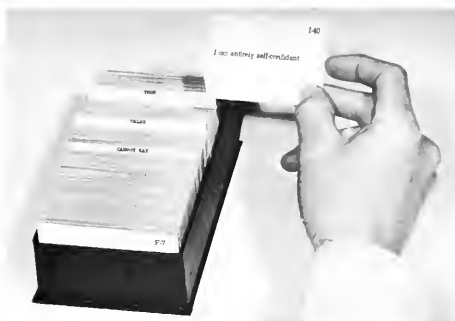
If we want to describe an individual's personality we look at his behavior in different ways, from different angles, or in different social settings. As we said earlier (p. 233), the different facets or segments revealed in this way are called *personality traits*. We also pointed out that traits are often referred

to as *surface aspects* in contrast with motivational or *depth dimensions*. Whether or not a thorough description of traits would also embrace the depth aspects is a moot question. It may be argued for instance, that traits are expressions of underlying motives.

The holistic approach used by the OSS included a certain degree of trait analysis, since the investigators looked for evidence of effective intelligence, emotional stability, initiative, and effectiveness in social relations. Likewise, projective tests are often used to discern such traits as introversion-extraversion, emotional stability, ego-involvement, and so forth. Thus there is no clear line which separates trait analysis from methods already considered. The approach which we are about to describe is nevertheless more obviously analytic or piecemeal than the holistic or projective approaches. Each trait test is designed to measure either one or a small cluster of traits — not the personality as a whole.

There are many tests purporting to measure this or that trait, but only a few can be described here. Most are of the pencil-and-paper variety. The subject writes his reactions to various questions, statements, or propositions and the test is scored quantitatively. Weights based upon earlier research are attached to each kind of reaction and the scores thus obtained are averaged and evaluated in terms of percentiles or other statistical norms.

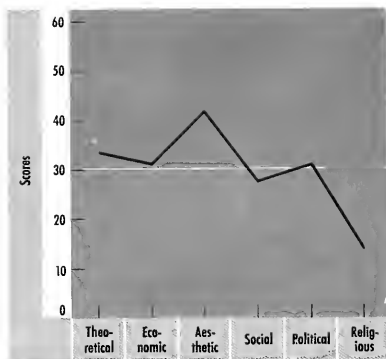
A widely used test has two forms, individual and group. This test, developed at the University of Minnesota, is known as the *Minnesota Multiphasic Personality Inventory* (or MMPI). It has 550 items.<sup>29</sup> The slant is decidedly psychiatric and scores are classified largely in terms of psychiatric categories. Thus are ascertained the person's leanings toward hysteria, mania, schizophrenia, and so on. When taking the individual form of the test, illustrated in Figure 9.8, a person is given 550 cards, each with a question. At the back of the box are three cards marked, respectively, TRUE, FALSE or CANNOT SAY. The subject is asked to read the statement and decide whether or not it applies to him. If it is true, or mostly true, he places it behind the TRUE card. If it is not usually true or not at all true, as applied to him, he puts it behind the FALSE card. If the statement does not apply, or if it



## 9.8 The Minnesota Multiphasic Personality Inventory.

Observe that there are three classification cards. These are, respectively, marked TRUE, FALSE, and CANNOT SAY. Each of the other 550 cards has a statement relating to some aspect of personality. The subject is trying to decide whether the card with the statement "I am entirely self-confident" should be placed behind the TRUE, FALSE, or CANNOT SAY card. How the person being tested rates with respect to hysteria, mania, and other psychiatric categories is gauged in terms of his pattern of response to items which are relevant to these disorders.

is something he does not know about, the subject puts it behind the CANNOT SAY card. Most of the items are very similar to those already cited in our discussions of introversion-extraversion and the Taylor Scale of Manifest Anxiety (p. 198). The latter was derived from items in the Minnesota Multiphasic Personality Inventory. They deal with what a person characteristically does in certain situations, with bodily complaints, with fears, with feelings, and so on. Of particular interest, however, is the fact that this test includes a number of "traps" for those who, instead of answering honestly, try to make a good impression. Suppose, for example, that a statement reads: "I sometimes put off until tomorrow what I should do today." The person who is trying to make a good impression will place this, and others comparable with it, in the false group. But the person who is reacting honestly will almost certainly say that this is true—it is true of almost everybody. If the score for such items is above a certain level the rest of the test is discounted, as yielding higher favorable



**9.9** Profile Based upon Scores from the Allport-Vernon-Lindzey Study of Values. The girl whose values are presented here is seen to rate highest on aesthetic values. Scores from 0 to 20 are significantly low; from 28 to 31, average; and from 40 to 60 significantly high.

scores than it should. High favorable scores on such items do, of course, reveal something about a person's desire to make a favorable impression. The number of CANNOT SAY items provides a check on carelessness in answering or on inability to understand the items. These and other checks are used to determine the validity of this inventory as applied to a particular person; that is, to test whether it is actually revealing in a particular person the traits that it is designed to reveal.

The *Allport-Vernon-Lindzey Study of Values*<sup>30</sup> is designed to reveal somewhat different aspects of personality from those measured by the test already described. It was devised to discover the weight given by a person to things theoretical, economic, aesthetic, social, political, and religious. The person who gives a very high place to social things and a relatively low place to others is sometimes referred to as the "social man." According to the psychologist on whose work this study is based, there are six "types" of men, each of whom gives the highest value to one of the spheres of life indicated above. A mixed type in which the values are balanced is also recognized.

The test has two parts. The first of these contains statements which the individual is to mark in terms of the alternatives given. Thus he says "yes" or "no" to the statement

The main object of scientific research should be the discovery of pure truth rather than its practical applications.

In the second part of the test the subject indicates which of certain alternatives appeals to him most, which seems next most important, which seems next important to that, and which represents his least interest or preference. He is also called upon to respond to items like the following:

When you go to the theater do you as a rule enjoy most —

- plays that treat the lives of great men
- ballet or similar imaginative performance
- plays with a theme of human suffering and love
- problem plays that argue consistently for some point of view

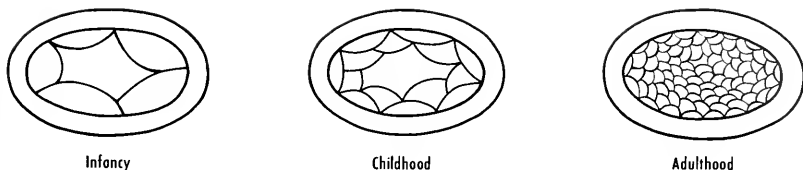
The various reactions to items on this test are given different weights in terms of their relevance to the six values. Finally a profile like that in Figure 9.9 is drawn.

When the scores based upon a variety of personality tests are put on a comparable basis — by translation into percentiles — a personality profile which represents all of the measured traits may be drawn. This tells us at a glance the person's relative standing with respect to each trait. Some individuals are consistently close to the central tendency, some are consistently above, and some consistently below. Most individuals, however, vary between average and extreme positions.

#### THE DEVELOPMENT OF PERSONALITY

Because babies differ in heredity, and possibly to some degree in their prenatal environments, it is not surprising that they look different and behave differently. These differences are small, compared with those of later childhood, but it is easy to see that some babies are "good-looking" and others "homely." The observer of a group of newborn babies will also see that some hardly emit a murmur, while





## 9.10 Diagrammatic Representation of Personality Growth. Think of the various areas as discernible personality traits. In infancy there are few, in childhood there are several more, and in adulthood there are many. (After Lewin.)

others squawk during almost every waking moment; that some are active, kicking vigorously and thrashing their arms about, while others lie relatively still; and that some suck at the nipple tenaciously while others suck with seeming indifference. This observer might conclude that, even at birth, babies have a personality. But are these differences in response stable? Is the newborn "squawker" characteristically a "squawker"? Is this mode of reaction revealed in later, more mature behavior — perhaps in the guise of verbal complaints? Are the various reactions which, at one moment of observation, differentiate one baby from another, consistently patterned, so that their various components can be observed to go together at later age levels? An affirmative answer to such questions would support the view that a newborn baby has a personality.

There are apparently only two aspects of the behavior of newborn babies which show some consistency from birth to later age levels. These are general activity (motility) and emotional expressiveness (temperament). Whether or not one accepts these as personality traits depends upon his definition of personality. Gordon Allport<sup>31</sup> feels that only those stable modes of behavior *adopted by the individual as a means of adjustment* should be regarded as personality traits. Motility and temperament, he points out, are primarily products of heredity, hence not *adopted* by the individual. Even though they play an important role in the modes of adjustment adopted later, Allport does not believe that they should be considered, in themselves, as personality traits. He says that the baby is probably around four months old before there is "sufficient learning and maturation

to form distinctive habits of adjustment or rudimentary traits." It is still later (the second half of the first year) before "adaptive responses to the physical environment and to people show marked distinctiveness."<sup>32</sup>

Whether or not one credits the newborn baby with personality traits is thus a more or less academic question. Certainly individual differences in both appearance and behavior are clearly apparent and some of the behavioral differences (as well as "looks") are more or less stable. As one writer<sup>33</sup> has said, at least "a personality nucleus" exists from the start.

Before the end of the first postnatal year there are a few personality traits which would be recognized as such even within a restricted definition like Allport's. As the child grows older, however, many more personality traits are added to the nucleus already present at birth. We find that such characterizations as dominant, persistent, sociable, selfish, negativistic, introverted and dozens of others seem applicable.

There is certainly a more or less gradual differentiation of the personality pattern with age. New traits emerge at various age levels until adulthood. Some psychologists represent this differentiation diagrammatically, as in Figure 9.10. The overall figure represents the total personality and the regions within it represent distinguishable personality traits.<sup>34</sup>

The innermost regions of our figure represent the so-called *depth factors* in personality. These are essentially motivational in nature, as was indicated in the preceding chapter. They are urges, desires, and aspirations which may be regarded as "mainsprings" of personality.

Freud did much to bring such inner aspects of personality to scientific attention and to stress their biological and social origins. In rather picturesque terms, he spoke of the total personality of the individual as consisting of three systems, the *id*, the *ego*, and the *superego*. These terms represent "inner forces" which drive the person to do what he does.

### The *id*, the *ego*, and the *superego*

The newborn baby, as we know, is activated purely by biological urges — by hunger, thirst, the need for warmth, the need for sleep, and so on. The *id* is a general term for such urges. This, according to Freud, "contains everything that is inherited, that is present at birth, that is fixed in the constitution."<sup>35</sup> There are no social considerations which influence the newborn baby's acts, for, as we said in an earlier discussion, it is at least two months old before social perception becomes evident.

Since the biological needs continue throughout life, the *id* is considered to be an ever-present ingredient of personality. However, the growing infant soon reacts to various aspects of its environment, including the social aspects. As this growth continues, the influence of biological urges is modified in various ways. While satisfying the "demands of the *id*," as Freud would say, the infant learns that its needs are met more readily and more effectively in certain ways and places than in others. Eventually, it acts or refrains from acting because of what it has learned about the consequences of its acts. Thus behavior becomes less blind, less naive, than at the beginning of life. To quote Freud again, "Under the influences of the real external world which surrounds us, one portion of the *id* has undergone a special development . . . a special organization has arisen which henceforward acts as an intermediary between the *id* and the external world. This region of our mental life has been given the name of *ego*."<sup>36</sup> Non-Freudians might refer to it as the *I* or the *self*. The important thing to recognize is that the baby begins life as a creature of impulse and that, as it grows older, it acquires ways of behaving which, although biologically rooted, are also dependent upon what has happened to it as an individual. These acquired aspects of its personality, which lead it to act or refrain

from acting in terms of what it knows rather than in terms of what it is biologically, are what we refer to as the *ego* or the *self*.

The child develops a *concept of self* as it learns to differentiate between its own body and objects and persons around it and as it comes to distinguish between self-initiated acts and those of other people. We can think of the child as reaching out toward the inanimate and animate things around him. In simple terms, he is learning what the surrounding world is like, how he differs from it, what will hurt him, what will bring pleasure, and let us say, "what he can get away with." Freud very aptly refers to this important process in the development of the *ego* as "*reality testing*."<sup>37</sup>

In reacting to its environment, the child eventually develops not only an *ego*, but also an awareness of right and wrong. This is the basis of what is commonly called *conscience* and what Freud calls the *superego*. Our *superego* is to a great extent dependent upon parental influences. As Freud says, "The long period of childhood, during which the growing human being lives in dependence upon his parents, leaves behind it a precipitate, which forms within his *ego* a special agency in which this parental influence is prolonged." As the *superego* develops, the *ego* is called upon to satisfy simultaneously, "the demands of the *id*, of the *superego* and of reality. . . ." The *ego*'s action is as it should be "if it is able to reconcile their demands with one another."<sup>38</sup>

### The role of the parent

From the time of birth there is a more or less constant conflict between what the child wants to do and what his parents and others want him to do. When he sucks his fingers, his parent says, "mustn't," "dirty," "only babies do that." There is much "hush, hush" concerning sex. He must forego the pleasure of playing with his sex organs. He must not go around naked. He must not ask questions about sex or look at the sex organs of other little boys and girls. He must not scratch. He must not say certain words. There are literally thousands of "must nots" drummed into the child's ear. Whenever he refuses to obey these parental inhibitions, he is punished, perhaps by a harsh word, perhaps by being

made to feel ashamed of his babyishness, perhaps by seeing the displeasure of his parents, perhaps by having various pleasures withdrawn, or perhaps by application of a switch or strap. In any case, he eventually comes to control his own behavior as the parents would control it; often repeating, as if they were his own, the parental words of admonition. The parent said, "You are filthy," and he now says or thinks, "I am filthy"; the parent said, "You should be ashamed of yourself," and he now says, "I ought to be ashamed of myself," or "I am ashamed of myself."

The superego represents this "interiorization" or "internalization" of parental prohibitions and reproofs. Since these are framed in verbal terms, their acquisition in such terms is to be expected.

The parents of course reflect the cultural patterns and values of their own society, as these were impressed upon them by their own parents, teachers, and others. Their influence is, however, not merely negative. They set a pattern, an example which, whether the child follows it or not, does much to influence his own conduct and his attitude toward himself and others.

In the course of such developmental organization as we have sketched, the child obtains his values, his ideals, his social attitudes, and a concept of his own role in the scheme of things. The parents are especially important because they get at him in his earliest, most dependent, and most formative years and because he is so long under their control.

### Defective superegos

Most of us develop a superego which adjusts us reasonably well to our society. We learn not to be destructive, to be honest, to tell the truth, to refrain from hurting those around us, to be conscientious with respect to the responsibilities thrust upon us and, in general, to be "good citizens," to have "a good character." But the superego of some, if they can be said to have one, is defective. Although such persons differ a great deal among themselves, they are sufficiently alike in certain respects to be designated, in general, as *psychopathic personalities*. Most are bright enough to have learned the lessons that others learn and they are not mentally ill; at least not in the same sense as the psycho-

neurotic and the psychotic people considered toward the end of this chapter.

Psychopaths are characterized, in general, by irresponsibility and disregard for the feelings of other people. They have a markedly defective character. They lack moral values. Although each psychopath has his own particular kinds of misconduct, the following are commonly found, singly or in combination: lying without restraint, stealing for no apparent purpose, assuming responsibilities with no intention of carrying them out, and committing sexual and other crimes with complete disregard for the rights and welfare of others.

Psychopaths tend to act on impulse, as if dominated by their id, or at least by their id and a very immature ego. How they failed to acquire the normal restraints is not known. Some of them come from homes of high, or relatively high, socio-economic status. Thus poverty is not a factor, as it frequently is in ordinary crime and delinquency.

The major source of psychopathic personality is some defect in interpersonal relations within the home. The individual may, to all outward appearances, have a very good home, with excellent parents. But his parents may lack affection for him, shower too much affection upon him, or use inadequate disciplinary measures. Indeed, extensive investigation of patterns of child rearing leads the investigators to conclude that a highly developed conscience comes largely through the mother's influence.<sup>39</sup>

We can say with some degree of conviction that mothers who love and accept their children, and who use love-oriented techniques of discipline rather than material or physical techniques, produce relatively more children with high conscience.

By love-oriented techniques they mean temporary withdrawal of affection, such as withholding the usual endearments. This is often quite influential if there is already a warm relationship between mother and child. Material and physical techniques involve material rewards, physical punishments, and withdrawal of privileges.

We have said very little about the broader cultural and other situational backgrounds of personality. Cultural influences are, as it were,

focused upon the developing child in the home, in school, and in the neighborhood. In addition to influences which stem from the culture itself, there are others—like having or not having brothers and sisters.

### SITUATIONAL INFLUENCES

We would possess a very different personality if we had been brought up by the Eskimos, the Sioux, the Balinese, or by some other cultural group. Not only would we dress differently, live in a different kind of dwelling, eat different food, use different implements and weapons, speak a different language, and have different social customs, but we would also have a very different conception of the world and of our own place within it. Our ego and our superego would differ greatly from what they are.

Cultural anthropologists have rightly placed much emphasis upon the "socio-cultural matrix" in which personalities develop.<sup>40</sup> If we are reared in the United States, we acquire a way of life, and with it, a personality, which an outside observer might well characterize as "typically American." But, even within this cultural matrix, aspects of personality may differ depending upon whether we are reared in the North or the South, the East or the West; whether we are reared in the country, in a city or a town; whether we grow up in the slums or in the best residential section; whether our early life is spent in a house or an apartment; whether our parents are rich or poor, together or separated, cultured or uncultured, religious or irreligious; whether we go to a standard, substandard or superior school; whether we have, or do not have, close friends; whether they conform, or fail to conform, to the mores of our culture; and so on.

Such socio-cultural influences are focused upon a child from the moment of birth and they continue to influence him all the days of his life. Some are especially influential in the early years and some not until the upper levels of maturity are reached.

#### Home influences

The most important early contacts are of course those between a child and its parents or guardians. These, as we have already sug-

gested, provide a focal point for the culture. Parental behavior—whether stern or affectionate, permissive or prohibitive—is often culturally patterned. Within our own culture, however, child care and training, although culturally patterned in many respects, leaves much to the discretion of the parents. If a child's parents are repressive and without overt affection, this often leads to introvert tendencies, the child withdrawing into a world of fantasy where, perhaps, he does what his parents will not allow him to do and he finds the affection denied him in real life. This is not the inevitable reaction to suppression and lack of affection, however, for the child's temperament, which is doubtless partly inborn, plays a role. The same objective situation, although fraught with the possibilities suggested, may actually lead to resistance and a show of defiance. "The same fire that melts the butter hardens the egg."<sup>41</sup>

On the other hand, the parents may be over-indulgent or overaffectionate, and they may encourage the child to "show off" in the presence of others, making him more extraverted than he might otherwise be. Then, too, they may encourage him to look to them for important decisions, creating a dependence that, with continued encouragement, may carry over into adult life. One mother may ask a child what kind of cereal he would like for breakfast, what book he would like to have read to him, which suit he would like to wear, and so on, requiring him to make his own decisions early. Another mother may give him what she thinks he ought to have and herself decide what he ought to wear and what he ought to have read to him. The second mother, wittingly or unwittingly, is encouraging dependency rather than independence.

How the parents react to curiosity about sex, what they say about relatives, about neighbors, and so on, all have possible effects.

Some parents continually go bull-headedly into conflict situations within the home, while others get around them in a manner conducive to eventual harmony and a minimal display of emotion. The following are illustrations of how children may be diverted from a certain course of action, yet without emotional disturbance.

A child came home from school with plans

to attend an amusement park with several of her friends. Her parents felt that the park was not a fit place for young children to go unaccompanied. However, the children had made their plans. The next day, a school holiday, they were going early in the morning and were to stay all day. Many a mother would say, "You can't go!"—perhaps giving the reasons for her objections—and arouse antagonism. The mother in question solved the problem without eliciting the display of emotion which such parental frustration might arouse. She agreed to let the child go, then dropped the matter for a time. At the supper table, however, she said, "Mary, since you are going to— park tomorrow and will be out all day, I think I'll go into town in the morning, do some shopping I've been wanting to do for some time, eat my lunch downtown, and go to see a movie. I'll be home in plenty of time to get your supper." The mother knew well enough the attractiveness of the respective alternatives. After a moment or two of hesitation, the child said, "Mother, do you suppose that I could go with you if I don't go to— park?" The mother said, "Why, if you'd rather do that, we can go downtown together."

A child of three insisted that he was going to take his teddy bear to Nursery School. His father said, "All right, you may take it." Then, after a few minutes, the father said, "People are going to say, 'Look at that baby carrying a teddy bear to school.'" The child replied, "I'm not a baby. I'm a big boy!" Then he said, "I think I'll leave Teddy home, he might get a cold." His father knew that the desire to be thought a big boy was more potent than the desire to take the teddy bear.

There is literally no end to the examples of home influence that one might give. The above illustrations serve to point out that it is very important for development of personality. Several recent documentary films have especially stressed the mother's influence. A case in which the mother's behavior was conducive to delinquency in her child was discussed in Chapter 2 (p. 33).

The same home situation does not, of course, always have the same effect. The child may become like the parent or just the opposite; he may conform or not, depending upon earlier modes of reaction and perhaps upon the sort

of individual he is constitutionally. Influences outside the home may also have their effect upon what the home itself does. One child feels trapped and does nothing about it, while another stays away as much as possible in the homes of friends.

### **The only child and birth order**

There has been much talk about only children having "spoiled" personalities, but psychological investigation has shown that, while some only children may be "spoiled," the personality of only children as a group is not different from that of children with sisters and brothers. One method has been to match only and not-only children for age, sex, socio-economic status, family organization, and I.Q. Personality tests were then given to the matched groups, which consisted of thirty children each. Teachers also rated the children for various traits. There were small differences, sometimes in favor of the only children and sometimes in favor of the not-only children. The chief difference was that the only children had a few more "sissies" and "tomboys" among them than did the not-only children.<sup>42</sup>

Onliness has possibilities fraught with danger to normal development, but these are only possibilities. What is more important than onliness as such is how the parents handle the situation. If the child has other children to play with—at home, in the neighborhood, or in a nursery school—and if his parents do not center too much attention upon him, there is no reason why he should be handicapped by his onliness.

Much has been written also about the youngest child and the oldest child in a family. Testing of children in different positions of the family hierarchy, however, has failed to show any evidence that birth-order is, on the average, related in any significant manner to the kind of personality developed. In individual cases, however, the fact of being an only child, or a child in some special birth-order, may be important in determining the personality of the child in question.<sup>43</sup>

### **Other social situations**

After the family situation there come, of course, the influences of the neighborhood, community, Sunday School, preschool, school,

church, peer group (age mates), and so on. Each such situation may leave its mark upon personality. Comradships within any of these situations have, of course, possibilities for good or ill. The situations themselves, like the home situation, may have unpredictable effects on personality. School makes scholars out of some children, while it makes other children haters of school and anything relating to it.

In high school, college, and business or professional life, the situations that we meet may have an influence on certain of our personality traits. But we are more resistant to change at these levels than earlier because, once certain habits and attitudes are acquired, they are somewhat resistant to change. Even though many individuals could change their personality in certain respects, especially by reacting differently to social situations, they seldom do so. One reason is that they are often pretty well satisfied with themselves as they are. This prevents them from recognizing that they may have traits which could be improved.

Sometimes, however, the situation forces a new type of adjustment, or, if it doesn't force a change, at least becomes conducive to change. One of the most interesting examples of this is the following experiment:

A small group of college men agreed to cooperate in establishing a shy and inept girl as a social favorite. They saw to it . . . that she was invited to college affairs that were considered important and that she always had dancing partners. They treated her by agreement as though she were the reigning college favorite. Before the year was over she developed an easy manner and a confident assumption that she was popular. These habits continued her social success after the experiment was completed and the men involved had ceased to make efforts in her behalf. They themselves had accepted her as a success. What her college career would have been if the experiment had not been made is impossible to say, of course, but it is fairly certain that she would have resigned all social ambitions and would have found interests compatible with her social ineptitude.<sup>44</sup>

#### THE NORMAL PERSONALITY

What is a normal personality? What is an abnormal personality? As we said earlier, the answer to these questions is not easy to find.

The words "normal" and "abnormal" have different meanings for different people. From the so-called normative view, anybody who is different from the one making the judgment is abnormal. In terms of the statistical view, however, anybody is abnormal who diverges very much from the average. The average person, according to this view, is the most normal one. From the purely social viewpoint, the normal person is the one who is adjusted to his environment to such an extent that he finds life enjoyable, and the abnormal one is the unadjusted — the one, in extreme cases, who would like to "get away from it all." To complicate the matter further, each of us may toe the normative, statistical, or social line with respect to some traits and not with respect to others. Moreover, we may be adjusted at times and not at others: for example, in a case of emergency or disaster. Generally speaking, however, the individual is regarded as normal if he has some socially acceptable goal around which his activities are integrated, if he finds the pursuit of his goal worthwhile, and if, in general, he gets pleasure out of living. The person who has no socially acceptable goal, who is at cross-purposes within himself and with his group, and who does not enjoy life as it is, but tries to shut himself off from it, is, generally speaking, regarded as having an abnormal personality.

It is well to recognize, however, that what passes for a worth-while goal in one society or social group does not necessarily pass for a worth-while goal in others. Moreover, what is perfectly normal behavior in one society may be abnormal in another. The Central Australian aboriginal goes naked all the time, and this casts no reflection on his personality. But if you follow his example in "civilized society," you will be regarded not only as abnormal but as a criminal as well. To belong to a colony of nudists in a civilized country may also be significant in regard to the individual's personality.

Although it is difficult to draw any well-defined line between what is normal and what is abnormal, there are certain well-characterized abnormal personality types.

The structural or organic personality disorders, as mentioned in Chapter 1, are those which have a known organic basis, like syphilis of the nervous system or hardening of the arteries of the brain.

Functional disorders, on the other hand, have no presently known organic basis, except acquired modifications of the nervous system which underlie the individual's particular attitudes toward himself and others.

## PSYCHONEUROTIC PERSONALITIES

Psychoneuroses (or neuroses) are relatively mild mental disorders. They include such symptoms as excessive fatigue and bodily complaints (neurasthenia), loss of memory or of sensory or motor functions (dissociation), and abnormal anxiety (anxiety neurosis). Although such disorders may cause great distress to the person afflicted with them, and be a nuisance to those who have to associate with him, they are usually neither incapacitating nor dangerous. Institutionalization is rarely necessary.

All personality disorders which fall within the psychoneurotic classification are generally assumed to be functional in origin. That is to say, they grow out of habits and attitudes acquired while the individual is attempting to adjust to his environment. They are varieties of *maladjustment*. A large proportion of the complaints with which general medical practitioners must deal are psychoneurotic, although thought by the patient to be organic.

### Neurasthenia

Many people have symptoms which, together, are called *neurasthenic*. The term itself implies a nerve weakness although, as we have said, there is no known organic basis. Here is an illustrative case from the files of a psychiatrist:

Ever since I have been married I've been nervous. If I didn't have the finest husband in the world and one who takes wonderful care of me and puts up with all of my complaining and all my sickness, I'd be a grass widow. . . . I haven't been a wife to him at all. I've been too sick. First there was that awful headache. Oh, I can't tell you how terrible it was. It just knocked me down, and I thought the end of the world had come. . . . But there's been a lot of other things. There's a sort of internal trembling, you know, a kind of inward nervousness, and I feel as though all my organs were quivering. One doctor told me

my nerves were tied in knots.

I don't know why it is, but I can't stand anything. I haven't strength enough to walk from here to the streetcar and back. I may get up in the morning feeling pretty good, but by the time I get breakfast for my husband and have started on my morning's work, I'm nearly exhausted, and by noon I'm just completely played out. . . .

I guess I told you about my sweating and getting so hot and then so cold. Did I tell you about that funny twisting feeling? It runs right through my right side down into my leg. I think it's a nerve loose or something like that. None of the doctors know what to make of my case. I've been to dozens of them. Yes, and I've tried osteopaths and chiropractors. I even went to the new psychology school and I don't know what all else. Some say I ought to try Christian Science, but you can't tell me these things are imaginary, and they are not in my mind either. I'll admit I'm nervous, but there's a cause for these things somewhere. I know I never had 'em before I was married.<sup>45</sup>

What is often lacking in such persons is a goal toward which they can direct their thinking instead of focusing upon bodily feelings. They often "hang onto" their ailments with grim earnestness like the shipwrecked sailor hangs onto a raft. Sometimes their ailments are "all they have." In many instances these provide a "good" excuse for failing to meet obligations or failing in marriage, the business world, or elsewhere. Like anybody else, these unfortunates are trying to adjust to the situations of life. But instead of facing their problems in a realistic manner, they find escape through sickness. They do not do this intentionally, but they perhaps learned early in life that sickness excuses one from many things, and even brings sympathy. They drifted gradually, and unthinkingly, into these mental disorders. Sometimes they are merely following a pattern set in the home.

### Indecision and doubt

The following case typifies a variety of psychoneurosis characterized by indecision and doubt.



**9.11 A Multiple Personality.** Mrs. "Eve White" of the Three Faces of Eve is shown taking a Rorschach test. She was, at various times, "a dull, unhappy housewife," a "hell-raising hoyden," or "a dignified, cultured woman." Subsequently a fourth personality, a more mature one, emerged. (Photo by Jack Woods, courtesy of Dr. C. H. Thigpen and *The Saturday Evening Post*.)

A boy in high school was supplied with some second-hand books. He began to doubt the accuracy of them, for, as they were not new, he thought they might be out of date and what he read might not be the truth. Before long he would not read a book unless he could satisfy himself that it was new and the writer of it an authority. Even then he was assailed with doubts. For he felt uncertain as to whether he understood what he read. If, for example, he came across a word of which he was not sure of the exact meaning, he could not go on until he had looked up the word in a dictionary. But likely as not in the definition of the word there would be another word with which he was not entirely familiar and he

would have to look that up, so that at times half an hour or more would be taken up in reading a single page, and even then he would feel doubtful as to whether he had got the exact truth.<sup>46</sup>

#### **Dissociation**

A large variety of psychoneurotic disorders are characterized by what has been called "dissociation." This may be defined as a state in which certain activities are no longer integrated with the personality as a whole. These activities are like bits of behavior "split off" from, yet coexisting with the rest. Many such conditions may be simulated in an hypnotic



trance. The term *hysteria* (p. 16) is often used to designate this class of disorders. Some of the symptoms of hysteria are sensory, such as functional blindness, deafness, and anesthesia (loss of cutaneous sensitivity). There are functional motor disorders, like twitching of muscles, paralysis of facial muscles or of limbs, and muscular spasms which may involve the whole body. There are memory disorders, like amnesia and fugue. *Amnesia* is loss of memory such as one often reads about in the newspapers. A person thus afflicted may wander off, forgetting his name and where he came from. A *fugue* is a confused state in which an individual may commit some deed, perhaps murder, but later have no recollection of it. *Dual personality* such as that represented fictionally in *Dr. Jekyll and Mr. Hyde* also falls within this general classification. Sometimes several alternating personalities are apparent in the same individual and we speak of *multiple personality*. The highly publicized book *Three Faces of Eve*, which was also the basis of a movie of the same name, deals with a multiple personality.<sup>47</sup> In Figure 9.11, "Eve White," one of these personalities, is pictured while responding to a Rorschach ink blot.

Although there are many theories concerning the origin of dissociative disorders, it is now generally conceded that they come from mental conflict, the tension or stress involved when the satisfaction of needs is thwarted or when one is "between the devil and the deep blue sea." Sometimes these disorders leave spontaneously when the conflict situation which produced them has been resolved.

A man who was engaged and otherwise obligated to a girl with whom he was no longer in love disappeared and was found wandering around in the Midwest, having forgotten his name, the girl, and everything which would identify his past. The girl finally jilted him and he gradually recovered his memory. This and many similar cases may look very much like malingerer, but there is ample evidence that assumption of such states is beyond the individual's control. He drifts into them gradually, perhaps wishing that he were not the person he is with the obligations he has. One interpretation is that he suggests or even "hypnotizes" himself into the states in question.

## Anxiety neuroses

Many psychoneurotics experience anxiety without sufficient cause. Abnormal fears (phobias), like fear of enclosed spaces, are anxiety neuroses. Sometimes the anxiety neurosis involves panic. The person becomes panicky for fear he is about to die or that he will commit some misdeed. He may actually go berserk. There is also a "free-floating" anxiety in which the person is anxious, but without knowing why he is anxious or about what. All he knows is that *something* dreadful is about to happen. The woman portrayed in Figure 9.12 says "Doctor, I'm worried, but I don't know why. I'm just worried. I have no reason to be, but I am." The tense attitude pictured here is typical.

**9.12 Acute Anxiety Neurosis.** The artist has pictured a typical anxiety neurotic—tense and anxious about nothing in particular. She is worried but does not know why. (After Dr. F. Netter, courtesy of Ciba.)



Anxiety neuroses appear to grow out of a conflict between (1) the individual's biological urges (as represented by the id), (2) the demands of reality (as represented by the ego), and (3) the dictates of parents and others (as represented by the superego). Freudians stress the threatening nature of this conflict. In essence, it involves the threat that his biological urges will overpower the individual, making him do what he knows he should not, or must not, do. He is anxious lest his repressed motives break through the "cultural veneer" and cause him to lose self respect, or the affection or respect of others.

When neurotic anxiety has a focus (as in phobias, p. 162) or when it concerns some organ (say the heart) it is said to be *displaced*. The focal situation, object, or symptom is a substitute for (or hides from the individual) the inner conflict which is the real source of his anxiety. Thus a man with homosexual tendencies may develop palpitation and an intense anxiety about his heart whenever he is alone with another man. His real difficulty resides in his homosexual impulses and the threat that he may try to satisfy them, hence bring disgrace upon himself. In cases like this, anxiety is not merely displaced; it also diverts attention from the "disgraceful" urges and, for the time at least, removes the threat.

#### PSYCHOTHERAPY OF PSYCHONEUROSES

There are many psychological procedures designed to alleviate psychoneurotic behavior. Most of these can claim a certain measure of success. Even talking with a person who will listen sympathetically sometimes relieves the psychoneurotic's tension. Quite often the only therapy involved is a series of interviews with a psychiatrist or clinical psychologist who can listen, question, and give what appears to be appropriate advice.

As our historical introduction indicated (pp. 16-17), hypnotic suggestion may relieve certain symptoms of hysteria. Freud used hypnosis before he hit upon the psychoanalytic procedures of free association and dream analysis. Psychoanalysis, he felt, gets at the root of the difficulty—at depth factors—hence is more effective than mere removal of symptoms.

#### Psychoanalysis

Psychoanalysis is today a widely used therapy. But different "schools" of psychoanalysis differ somewhat in their procedures and also in their interpretations of what these reveal.<sup>48</sup>

In typical psychoanalytical procedure the patient reclines on a comfortable sofa and is encouraged to say everything which comes to mind, the analyst occasionally directing association by asking certain questions. The patient may reach a point where blocking occurs or where ideas seem too ridiculous, or too filthy, or too horrible for expression. Here the analyst urges the patient to express the ideas in question. Many such séances may eventually lay bare the significant aspects of the individual's life history. Sometimes, in the course of these séances, the individual breaks down emotionally—weeping, cursing, and so on. This emotional flareup is often found to have therapeutic value. In dream analysis the patient relates his dreams and these are analyzed for what they may reveal about his motives and about other "depth" aspects of his personality.

The analyst usually interprets the findings and tells the subject what is wrong with him and what to do about it. These interpretations and the advice given are usually colored by psychoanalytic theories.

#### Client-centered therapy

A form of interview used for therapeutic purposes and regarded by many as a substitute for psychoanalysis has been developed by Rogers<sup>49</sup> and his followers. It is known as "client-centered" therapy. This usually requires much less time than psychoanalysis. It also differs from psychoanalysis in another, more important respect: the counselor refrains from telling an individual the nature of his problem and what he should do about it. A psychoanalyst, as we have seen, injects guidance based upon the patient's reveries and upon analysis of his dreams. Since these features are absent from Rogers' procedure, it is called "nondirective." The "client-centered" designation suggests that with this procedure the client rather than the counselor plays the central role in achieving a solution.

The following excerpts from transcribed interviews illustrate the general nature of client centered therapy and also why it is so designated. Observe that the counselor says very little. Note, also that the client himself here develops insight into what his problem is and what he should do about it. The counselor's aim is to facilitate the gaining of such insights. When achieved, they are recognized by the client as his own rather than the counselor's. He is thus likely to accept and to act upon them.

*Excerpt from first interview*<sup>50</sup>

S (subject). Well, it's just reached the point where it becomes unbearable. I'd rather be dead than live as I am now.

C (counselor). You'd rather be dead than live as you are now? Can you tell me a little more about that?

S. Well, I hope. Of course we always live on hope.

C. Yes.

S. But—No, I don't have any conscious suicidal urge or anything like that. It's just that—looking at it rationally, I feel that I'm—that I'm in the red now and I wouldn't want to keep on living in the red. (Pause)

C. Well, can you tell me in any more detailed way what—in what way it blocks you so much that you really feel sometimes that you'd be better off dead?

S. Well, I don't know if I can any more accurately describe the sensation. It's just a—a very impressive and painful weight as if an axe were pressing on the whole abdomen, pressing down, I can almost—I can almost sense the position and I feel that it is oppressing me very radically, that is, that it goes right down to the roots of my dynamic energy, so that no matter in what field I assay any sort of effort, I find the blocking.

*Excerpt from eighth and final interview*

S. Well, I've been noticing something decidedly new. Rather than having fluctuations, I've been noticing a very gradual steady improvement. It's just as if I had become more stabilized and my growth had been one of the hard way and the sure way rather than the wavering and fluctuating way.

C. M-hm.

S. I go into situations, and even though

it's an effort, why I go ahead and make my progress, and I find that when you sort of seize the bull by the horns, as it were, why it isn't so bad as if you sort of deliberate and perhaps—well, think too long about it like I used to. I sort of say to myself, "Well, I know absolutely that avoiding the situation will leave me in the same old rut I've been taking," and I realize that I don't want to be in the same old rut, so I go ahead and go into the situation, and even when I have disappointments in the situation, I find that they don't bring me down as much as they used to.

C. That sounds like real progress.

S. And what pleases me is that my feelings are on an even keel, steadily improving, which gives me much more of a feeling of security than if I had fluctuations. You see, fluctuations lead you from the peaks to the valleys, and you can't get as much self-confidence as when you're having gradual improvement.

C. M-hm.

Psychoanalysts have claimed that this technique insufficiently probes the "depths" of personality. Whether or not it is necessary to go so "deep" cannot be decided until adequate comparative studies on the relative effectiveness of these two therapeutic procedures have been carried out. It may well be that some psychoneurotic conditions yield better to one approach than to the other.<sup>51</sup>

### **Group therapy**

Group therapy is another procedure devised to alleviate psychoneurotic and other difficulties.<sup>52</sup> This may involve aspects of the therapies already mentioned, but it gets its name from its application to more than one individual simultaneously. Two or more persons with somewhat similar problems meet to talk about them under the guidance of a counselor, usually a psychiatrist or a clinical psychologist. It often helps a person to learn that others have similar problems. In the group situation, moreover, individuals may support each other in efforts to solve mutual problems. Alcoholics Anonymous works on this principle. When problem situations are acted out by the persons concerned, we have a form of group psychotherapy known as *psychodrama*.<sup>53</sup>

Many psychoneurotics get better sponta-

neously after conflicts have resolved themselves. It is with the psychoneuroses, moreover, that various cults and forms of faith healing have had their major successes. Mild tranquilizers\* are also widely used to reduce neurotic tensions and anxiety.

## PSYCHOTIC PERSONALITIES

Psychoses are much more serious than psychoneuroses. There is usually a marked psychological deterioration. The individual is often out of contact with reality. He may have hallucinations (false perceptions). He may for example, see visions and hear voices without any objective basis. He may even "taste" ground glass or poison in his food. He may also have false judgments and jump to false conclusions; in short, be deluded or have delusions. Thus a patient may have the delusion that he is God, that he is the head of the institution in which he is a patient, or that a sucking machine operating from some distant place is drawing his vital energy from him.<sup>54</sup>

The absurdity of such delusions shows how lacking in insight psychotic people may be. It is not uncommon for a psychoneurotic to call himself "neurotic" and even to laugh at himself. But the psychotic is usually sure that he is all right and the world all wrong. Psychotherapy may help some such patients, but with others it is quite ineffective, largely because of communication difficulties.

Psychotics are often dangerous to themselves and to those around them, hence one must usually place them in hospitals where they can be treated and looked after. Many

get well, but others must be institutionalized for long periods. In fact, psychotics occupy more hospital beds in this country than do all other ill patients put together.

There are, as we have seen, two broad classifications of psychoses. Those with a known organic basis, like syphilis and alcoholism, are said to be *organic*. Those without any associated gross organic pathology are known as *functional*. Should it be found, however, that a psychosis now classified in the latter group is due to some structural or biochemical defect not yet evident, the psychosis would then be designated as organic. Actually, the differentiation that is customarily used, and which we adopt here for convenience in discussion may, in the long run, turn out to have been an artifact.<sup>5</sup>

With respect to schizophrenia, a "functional psychosis" to be discussed presently, there is already much controversy about proper classification. One statistical study shows that schizophrenia tends to run in families. Moreover, if one identical twin becomes schizophrenic, the other will, in 86 out of 100 cases, also develop schizophrenia.<sup>55</sup> Some have questioned the adequacy of these statistics.<sup>56</sup> But, even if they should be substantiated, there are at least two possible interpretations. One is that a susceptibility to schizophrenia is inherited, hence that the disease has an organic basis. Another is that individuals who are related, and especially those who live under the same conditions, may acquire their attitudes or modes of thinking from those around them. This would be a functional interpretation. There is even the possibility

\* There are two general groups of so-called "tranquilizers." All tend to have a quietening effect upon the organism, both animal and human. The milder group (derived from meprobamate) go under a variety of trade names and are sometimes prescribed by physicians to calm their anxious and tense patients. More powerful tranquilizers (including chlorpromazine) are used especially with schizophrenics and, according to recent reports, are known to have rather specific effects upon the reticular formation of the brain stem (pp. 187-188). See especially Cazzullo, C. L. "Biological Aspects of Pharmacodynamics in Psychoses," pp. 331-340 in Rinkel, M., and H. C. B. Dember (Eds.), *Chemical Concepts of Psychosis*. McDowell, Obolensky, 1958.

<sup>5</sup> The problem of differentiating between so-called "functional" and "organic" psychoses is, in essence, as Stanley Cobb, the eminent psychiatrist, has stated it in the following quotation from his *Foundations of Neuropsychiatry* (6th Ed.). Williams & Wilkins, 1958, p. 127. He says, "It may seem pedantic to expatiate upon the impossibility of drawing a line between 'organic' and 'functional,' but experience shows that it is necessary to emphasize that no such line can logically be drawn. If it be drawn arbitrarily, its position is ordained by the point to which technology has advanced in that year. It depends on what kind of a 'scope,' 'graph,' or 'meter' is used by the observer. In other words, the line between organic and functional (and between physical and mental) is an artifact."

that both an inherited disposition and an acquired one are interlinked. It is possible, for instance, that there is an inherited tendency to break down under stress *if* the individual is subjected to unusual stress, but even then, only if he has acquired inadequate ways of facing problems.

The question as to how schizophrenia should be classified is also complicated by medical research. Investigators have reported from time to time that schizophrenics suffer from glandular defects, disturbed bodily metabolism, and chemical malfunctions of various kinds.<sup>57</sup> So far, no such claims have been sufficiently substantiated to warrant general acceptance. But even though a biochemical defect should be found to accompany schizophrenia, it would still be necessary to prove that this was the cause of the disease rather than a bodily disturbance which developed subsequently. We have seen in discussing emotion and psychosomatic disorders (p. 216) that psychological stress often disturbs a person's biochemical equilibrium.

Should an organic basis for schizophrenia be found (hereditary or otherwise) one would still be confronted with the fact that different people classified as schizophrenic exhibit very diverse combinations of symptoms. This being so, it is evident that their ways of behaving and thinking must have been acquired through individual experience. Thus, if an organic basis were found, it would indicate only a *predisposition* toward an exact pattern of mental illness. It would not account for the actual breakdown nor for the combination of symptoms found in a particular case.

In view of the above, we will regard the so-called "functional psychoses," tentatively at least, as maladjustments arising out of peculiar attitudes which the individual has developed toward his world, including his relations with other people.

### Organic psychoses

The organic psychoses most clearly recognized are general paresis of the insane, senile psychosis, and alcoholic psychosis.

*General paresis.* This is due to syphilis of the brain (Figure 9.13). But only a small proportion of people who contract syphilis become paretic. If syphilis is treated and



**9.13 A Normal and a Paretic Brain.** When a normal brain (top) is compared with a paretic brain (bottom), the cortical destruction in advanced paresis can be clearly seen. Not every paretic brain shows such widespread deterioration. Indeed, as indicated in the text, paresis is today usually cured in its early stages. (Top photo from Gardner, E., *Neurology*, 3rd Edition. Saunders, 1958, p. 11. Bottom photo from Jelliffe, S. E., and W. A. White, *Diseases of the Nervous System*, 6th Edition. Lea and Febiger, 1935, p. 821.)

cured early, as it now can be with penicillin, general paresis will never occur. It usually comes several years after the earliest evidences of untreated syphilis have disappeared.

Here is the case of a person who contracted syphilis and was not cured, although all symptoms eventually disappeared. His paresis came on about thirteen years after he thought he was cured of syphilis. Brought before a class in abnormal psychology, he showed absence of certain reflexes and exaggeration of others, his speech was thick and he could not distinctly say such things as "black bug's blood." Moreover, he swayed slightly when his eyes were open, a great deal when his eyes were closed.

"Mr. —, how are you feeling today?" "Fine, never felt better in my life!" "How are you off financially?" "Oh, I'm doing quite well. I have one billion dollars in the — bank and another billion in the — bank." "Have you any children?" "No. We had one, but it died at birth. I'm going to pick up a half dozen at — hospital on my way back to —. I'm going to get four girls and two boys." "What are you going to name them?" "Well, I guess I'll name the four girls after the Dionne quintuplets." "Which ones?" "All of them." "But aren't there five quintuplets?" "Five! Well, what the hell!"

Before this patient came into the hospital he was threatening to kill people who "had done him some wrong." He said he was not now mad at anyone. He was being given malarial and drug therapy and had shown considerable improvement since entering the institution. This is not necessarily a typical case, for every case is different in many respects. But delusions of grandeur (billions in the bank, picking up six children on the way home, and the like) are often found in such cases.

*Senile psychoses.* These psychoses present a variety of patterns. Quite often there are delusions of one sort or another. One old man asked the doctor to bore a hole and let out some of the air that was pressing down on his brain, talked of people trying to poison him, and so on. Such delusions are common in senile cases. There are also defects of memory. The patient may forget recent events. False memories may occur, as when the senile person tells you he did something a few moments ago that he could not have done because he was sitting before you in the room. Quite often there is disorientation, the patient not knowing where he is, what year it is, how long he has been in the institution, and so on.

*Alcoholic psychoses.* Psychoses brought on by excessive use of alcohol take many forms, including the well-known delirium tremens, in which the victim has terrifying hallucinations. Sometimes the disordered behavior is similar to that found in senile psychosis. It may also simulate certain aspects of paranoid schizophrenia, a functional psychosis to be considered shortly.

## Functional psychoses

The most frequent of these are manic-depressive psychosis and the various forms of schizophrenia.

*Manic-depressive psychosis.* This disorder is characterized by extreme ups and downs of mood. In the manic state the individual may be extremely happy, singing at the top of his voice, dancing around, working on inventions that will "shake the world to its foundations." He may also be so obstreperous that he must be kept under restraint of some kind. Delusions and hallucinations are often present. In both men and women, vile language, curses, sexual allusions, and sexual displays are common. Sometimes there is a "flight of ideas," the individual going off on one tangent or another as each idea occurs to him.

In the depressive state, these people present an even more pitiful picture. Many of them cry continually, accuse themselves of all kinds of sins, refuse to eat or drink because "it would be a sin to keep this evil body alive" and try to commit suicide. Such patients are, of course, tube-fed and watched closely to see that they do themselves no harm. The manic and depressive states alternate in a variety of ways. Some patients go into only one state, with periods of normalcy in between. Others have a period of depression followed by normalcy, and then by mania.

Many people with a manic-depressive psychosis get well. Some, of whom Clifford Beers is the best known, have written books about their experiences as patients in mental hospitals. Through his book, *A Mind That Found Itself*, and the mental hygiene movement which he was instrumental in starting, Beers did much to improve conditions in mental hospitals and to further public understanding of the nature of mental illness and how it may be prevented. We will have more to say about this shortly.

The extreme mania and depression that Beers experienced is now seldom seen in mental hospitals, the reason being that tranquilizers are being widely used to reduce tension and excitement.<sup>58</sup> When these are ineffective in controlling depressive states, electric shock therapy (electroconvulsive therapy, or E.C.T.)

is often used. This involves passing a weak electric current through the brain, from electrodes placed on the skull. The patient is thrown into a mild convulsion followed by a brief period of unconsciousness. A series of such treatments, days or weeks apart, often leads to recovery. Why electric shock treatments are effective in relieving depressive states is not known. There are several theories, but we will not discuss them here.<sup>59</sup> The gains achieved by electric shock treatments are often maintained with the help of tranquilizers.

**Schizophrenia.** This, literally, is a "splitting of the mind." The designation *schizophrenia* is now more widely used than the earlier term, *dementia praecox*, which means "youthful insanity." While this disease does usually make its appearance in youth, it often occurs in individuals ranging in age up to the middle years of life.

A general characteristic frequently observed in schizophrenics is withdrawal from normal contacts with other people. This is an extreme form of introversion. The patients shown in Figure 9.14 are schizophrenics who illustrate withdrawal as well as other symptoms.

There are actually many symptoms embraced by the term *schizophrenia* and each individual so classified has his own combination. Nevertheless there is enough similarity

amid this diversity to warrant the use of certain class names. Four categories of schizophrenia are widely recognized. These are *simple schizophrenia*, *hebephrenic schizophrenia*, *catatonic schizophrenia* and *paranoid schizophrenia*. Some distinguishing characteristics of each are considered shortly. However, the classification of a particular disorder is often far from simple. Psychiatrists occasionally even disagree as to whether it is schizophrenic or manic-depressive and, if schizophrenic, as to how it should be further classified. It is not uncommon, in fact, for a patient to remain unclassified, or to be referred to as a "mixed type."

From the following descriptions of the four major schizophrenias one will see that the care, treatment, and outcome of a disorder differ somewhat depending upon its classification.

*Simple schizophrenia* is characterized by a general mental retardation, and "emotional blunting." The patient sits and stares into space, has no ambition, would just as soon be riding freight cars, walking the street, or living in the institution as doing anything else. These schizophrenics give the appearance of being extremely introverted, living within themselves, and taking no interest in what goes on around them. It is seldom that anything can be done for them. Sometimes they stay in the

**9.14 Schizophrenic Withdrawal.** Such attitudes, combined with disarray and lack of interest in surroundings, are typical. (Photo at left by Larry Keighley and courtesy of J. B. Martin and The Saturday Evening Post. Photo at right courtesy Saint Elizabeth's Hospital.)



institution vegetating until they die, even at an advanced age; but in recent years real progress has been made in training such schizophrenics and returning them to their homes and the community.

*Hebephrenic schizophrenia* is notable for silliness and general incongruity of actions. A woman so classified was found in the men's room at the bus station with all of her clothes off, washing them, in fact, in the washbowls. She was laughing and generally silly about it. She even treated it as a big joke when it was discussed with her before a class. During the course of the session, she grimaced, made peculiar silly gestures, and failed to respond in a reasonable way to the questions asked her. She would probably giggle if told that her mother had died. One hebephrenic patient etched her name on her leg with a hairpin.

Many hebephrenics use bizarre words and expressions which they appear to invent and which have no meaning to others. One patient responded to all questions with the statement "16-21 telephone pole." But, after being treated with a tranquilizer, she said that "she was born in a small village, consisting of six homes, and that her home was situated near a telephone pole numbered 16-21."<sup>60</sup> Hebephrenics may also recover their sanity.

*Catatonic schizophrenia* often involves pec-

uliar postures and actions. These differ from one patient to another and in the same patient from time to time. A catatonic is shown in Figure 9.15. Postures like this may be held for many hours. If the posture is changed by anyone else, the patient may resist the change, and when released, resume the former position. Sometimes he may be molded. His arm is put in a certain position by the doctor and he holds it in that position for a long while. This susceptibility to molding is often referred to as "waxy flexibility."

The patient may not have talked for years. The negativism which underlies this is illustrated by the following example: A psychiatrist who was giving a clinic could not get the patient to speak. He had actually not spoken for ten years. The doctor turned to the class saying, "This patient has not spoken for ten years," whereupon the patient said, "What do you want me to say?"

These patients often have to be tube-fed and also carried around when they refuse to eat or walk. Sometimes, while sitting like a statue, they smile to themselves as if amused at something running through their heads. They are the most extreme examples of introversion that one could see. "Withdrawn," "shut-in," "encapsulated," "insulated," are terms which aptly describe them. Catatonics sometimes



### 9.15 Catatonic Posture.

The patient says he is "reaching for my nerves." Catatonics hold such postures for hours. If the doctor interrupts the posture, they return to it. Some without postures of their own are "plastic" in that, when placed in a posture, they hold it for a time. (Photo by Larry Keighley and courtesy of J. B. Martin and The Saturday Evening Post.)



become highly excited, in which case they can now be calmed with certain tranquilizers.\*

*Paranoid schizophrenia.* This is in many ways the most spectacular form of schizophrenia. The silly gestures and bizarre verbal expressions of the hebephrenic are absent. A paranoid schizophrenic speaks quite lucidly, and often quite convincingly, about an unreal world. Indeed, this disorder gets its name from the fact that paranoid delusions are often present. That is, delusions in which the individual sees reference to himself in what he assumes is taking place. Thus he has the idea that people are poisoning him, that ground glass is being put in his food, that his organs are all made of rubber, that he has no blood, that people are spying on him, and so on. Many cases thus classified have delusions of grandeur rather than, or in addition to, those of reference. Quite often there is a wide variety of symptoms.

Mrs. ——— was a successful nurse, but began to get the idea that she was being spied upon by her neighbors, that men were hiding in her attic at night with a view to seducing her, "an honorable woman." She is a great inventress, having invented a powderless, triggerless, shell-less, report-less, barrel-less gun — in fact a peace gun. She has sold it to the government, but spies are everywhere in the institution and the superintendent is in league with them. She has the idea that there may be some spies in the class, so she asks everyone to raise his right hand and say, "God Save America." Then she is satisfied and continues with her harangue, hinting that even greater inventions are coursing through her mind. She switches to religion, telling what a pure righteous woman she is. She was "monkied" with ten years ago and is to give birth to five monkeys. She says her term is a long one because hers is a Caesarian case. When the doctor says, "All right, Mrs. ———, you may go back now," she becomes quarrelsome, ac-

cusing him of not wanting these boys and girls to know that he is keeping her, a perfectly sane woman, in this place. She is edged out of the room, but slips a piece of paper to a girl sitting near the door. It says, "This is a house of ill repute, you had better get out of it while you have the chance."

Another patient has the delusion that he is dead. Asked, "Do dead people bleed," he replies, "No, of course not." His finger is then pricked and a drop of blood oozes out. "There, now," he is told, "you bleed, so you can't be dead." He replies, "Well, all that shows is that dead people *do* bleed."

Some tranquilizers serve to quiet paranoid schizophrenics while others often lead them to give up their delusions.<sup>61</sup>

*Therapy in schizophrenia.* When schizophrenics can be induced to "come out of their shell" to the extent that intercommunication is possible, much can be done to help them develop insight and assume a realistic approach to their problems. When tranquilizers bring schizophrenics "back to reality," various forms of psychotherapy are available. It is possible to discuss the patient's problems with him and to help him meet them realistically. Group therapy is now widely used with schizophrenics. A group of patients meet to discuss their problems with each other and with members of the hospital staff. Psychoanalysis is also being used with schizophrenics.<sup>62</sup>

Tranquilizers and psychotherapy are to a considerable extent replacing shock therapy. We have already discussed the use of electric shock therapy with depressed cases. The treatment used most often with schizophrenics, however, is insulin shock. Large injections of insulin lower the patient's blood sugar to the level where a coma is produced. Then carbohydrate is injected in sufficient quantity to return the blood sugar to normal, and the patient to consciousness. This procedure may be repeated at intervals of days or weeks. Many patients so treated regain their sanity, but why the treatment has this effect is not known.

Some schizophrenics get well spontaneously — that is to say, without special treatments. Thus a question which naturally arises is whether those who get well after shock treat-

\* A catatonic who recovered and devoted himself, as a Chaplain, to helping others in similar predicaments has written his story and given his interpretation of schizophrenia. See Boisen, A. T., *Explorations of the Inner World*. Willett, Clark, 1936.

ments would not have regained their sanity anyway. However, the statistics on recovery with and without insulin shock show that more get well with these treatments than recover spontaneously.

Some patients who get well have relapses. This may be due to the fact that they must leave the sheltered life of the hospital to return to intolerable conditions which contributed to their illness in the first place. No doubt the tranquilizers, which patients often continue to take after returning home, help many to avoid a relapse. Some mental hospitals also facilitate adjustment outside by having their psychiatric social workers improve the patient's home neighborhood and work situation before he returns. This requires re-education of those with whom he will be intimately associated.

Brain operations known collectively as *psychosurgery*<sup>63</sup> are used in certain cases of schizophrenia and manic-depressive psychosis which do not respond to other treatments. Psychosurgery involves either the cutting of nerve fibers or the removal of brain tissue in the frontal lobes of the brain. This "operation of last resort" is much less frequently performed now than in the past, the reason being that shock treatments and tranquilizers often make it unnecessary.

Psychosurgery produces a radical change in the individual's "self-structure." It does not greatly impair his general intelligence as measured by the usual tests, but it makes him, in many respects, a "different person." He is rendered less anxious, less concerned with what others do or say or think, and less concerned with the past and the future. The life which seemed intolerable to him is now tolerable. He is serene and contented with his lot. But he gains serenity at the expense of individual drive and initiative.<sup>64</sup>

A recent survey shows that early use of the tranquilizer known as *chlorpromazine* produces more recoveries from schizophrenic symptoms than other medical therapies, including electric and insulin shock. The writers say, "In the light of our results and all other evidence available to date, it seems probable that there will in the future be very little need for E.C.T. [electroconvulsive therapy] and deep insulin therapy as the primary treatment of schizophrenia and the leucotomy operations

[psychosurgery] are contra-indicated unless in exceptional circumstances."<sup>65</sup> They point out, on the other hand, that E.C.T. and subcoma doses of insulin sometimes increase the effectiveness of chlorpromazine, hence may continue to be used for this purpose.

## PREVENTING PERSONALITY DISORDERS

We have said a great deal about the nature of personality disorders and also about methods designed to make the mentally ill person well again. But how about the much more important goal of preventing such disorders? This, as indicated earlier, is the aim of mental hygiene.

Education of the general public with regard to mental illness is one important function of mental hygiene. The reader has learned that personality disorders originate in organic disease or in maladjusted modes of thought and action. He knows that they have a natural and not a supernatural origin. This fact should be widely publicized so that the mentally ill will be regarded as sick rather than "possessed." It should also be more generally recognized that mental illness is preventable and that the mentally ill can be cured and rehabilitated.

Parent education is important in preventing mental illness. There is no "pat" formula to be applied in raising a mentally healthy child, for every child is different and what works with one may not work with another. Moreover, a certain procedure is sometimes applied effectively by one parent and not by another. But there are certain general principles of which parents should be cognizant. For example, they should recognize the need of children for affection, for security, for worth-while interpersonal relations. They should learn to refrain from pushing a child beyond the limits of his intellectual and other capacities. They should realize the need to develop independence rather than overdependence. In short, they should be informed rather than ignorant about the psychological aspects of child development.

Clinics for the treatment of behavior disorders in children are also important. In the second chapter we discussed a film called *Angry Boy*. This illustrated what a child guidance clinic staffed by psychiatrists, psy-

chologists, and social workers can do to correct personality disorders at their source. The boy's parents, in their relations with each other and with him, were partially responsible for his difficulties. His actions were in large measure brought on by hostility toward his mother. Improving the home situation did much to correct the boy's attitudes. But, as is often the case in behavior clinics for children, play therapy was also undertaken.<sup>66</sup> The psychiatrist, who came to be regarded by the boy as his best friend, competed with him in target practice with a toy pistol and at the same time carried on a running conversation. Introduced into this were allusions to the boy's hostile impulses, and aggressive acts. There were also questions concerning events leading up to his difficulties. At one stage the boy turned his hostility upon the psychiatrist, "shooting" him in the head. This led to conversation about hurting people, even those you like.

Doll play, similar to that involved in the projective tests already discussed, is often used as a form of therapy. In indirect ways, as in the play of the "angry boy," this may bring hidden impulses into the open, thus providing the therapist with information that is useful in re-educating the child.

Another aspect of mental hygiene focuses upon adolescents and adults, the aim being to increase their self-understanding and thus help them solve personal problems. A course in general psychology may contribute to these ends. Moreover, many colleges and centers for adult education offer special courses deal-

ing with various aspects of psychological adjustment.

A widely used textbook<sup>67</sup> on the psychology of adjustment cites the following as some principles conducive to mental health: good physical health, accepting yourself, accepting other people, maintaining a confidential relationship with someone with whom you can discuss your problems, assuming an active attitude toward difficulties which is aimed at overcoming them, participating in social activities, finding a satisfying line of work, finding enjoyment in creative undertakings, and using the scientific approach to solution of personal problems. The authors point out, in elaborating upon these, that the principles are not easily applied and that many individuals need professional help.\*

\* Professional help is sometimes available in a college or university. Many communities also have mental health clinics. The National Association for Mental Health, 1790 Broadway, New York 19, N.Y. publishes a *Directory of Outpatient Psychiatric Clinics*. A *Directory of American Psychological Services* is published by the American Board of Psychological Services, 9827 Clayton Road, St. Louis 17, Mo. It contains a listing by state and community of qualified clinics and individuals offering psychological services. Qualified psychologists may also be identified through state boards of examiners in psychology (which function in states with certification laws) and through the *Directory of Diplomates in Professional Psychology* published by The American Board of Examiners in Professional Psychology and available from the Secretary-Treasurer of the Board, Dr. Noble H. Kelley, Southern Illinois University, Carbondale, Illinois.

## Summary

Personality may be defined as the most characteristic integration of an individual's structures, modes of behavior, interests, attitudes, abilities, and aptitudes—especially from the standpoint of adjustment in social situations. Measurable aspects (or dimensions) of personality are referred to as personality traits. The search for primary (irreducible) traits uses the techniques of factor analysis. To date, however, a definitive

list of personality traits has not emerged. Character refers to moral or ethical traits. In addition to the so-called "surface" traits of personality there are "depth factors" of which the individual himself may or may not be aware. When these are nonconscious or "unconscious," they may be revealed by psychoanalytic and other procedures, including projective tests.

Investigators have often attempted to dis-

cover personality types, such as introverts and extraverts. Introversion-extraversion tests reveal a normal rather than a bimodal distribution, hence no evidence that people are in general, either introverts or extraverts. Most fall toward the center of the distribution and are classified as ambiverts. Whether persons may be typed with respect to physique and temperament and whether there is any valid correlation between the two is still an open question. One investigation has presented evidence for three dimensions of physique (endomorphy, mesomorphy, and ectomorphy) and three related dimensions of temperament (viscerotonia, somatotonia, and cerebrotonia). Subsequent research has in some instances supported and in others refuted the finding that these physical and temperament dimensions are significantly correlated.

The glands which most directly influence personality are the anterior lobe of the pituitary, the adrenal cortex, the thyroid, and the gonads. There is a close interrelation of glandular functions. Through its secretion of ACTH, and growth and gonad stimulating hormones, the anterior pituitary plays a key role. Glandular secretions have much to do with such aspects of personality as physique, general energy level, and sexual functions and interests.

Personality assessment may be holistic (observation of behavior as a whole in a broad social setting), projective (using tests like the Rorschach and T.A.T.), or involve tests of relatively restricted traits (introversion, neuroticism, and so on). The trait approach may utilize behavior situations or pencil-and-paper check lists. It is not unusual for holistic, projective, and trait approaches to be used in combination.

Whether a newborn child does or does not have a personality is controversial, but there is no doubt that clearly recognizable personality traits are present in the first few months of life. More appear with age and experience, seeming to differentiate out of a pre-existing whole. Biological and situational (including cultural) influences are both significant for personality. One biological influence is represented by the id (physiological needs). By a process referred to as reality testing, the ego (self) and superego (conscience) develop. The parents (especially the mother) play an

important role in moulding the personality of the child. When an inadequate superego develops (as in psychopathic personality) the home situation is probably responsible. Again, the mother's influence appears crucial. Being an only child does not have deleterious effects on personality so long as contacts with other children are provided and the child is not the focus of too much parental attention.

The normal person has some socially acceptable goal around which his activities are integrated, he finds pursuit of his goal worthwhile, and, in general, enjoys living.

Clinical types of abnormal personality are classified: (1) as organic or functional, and (2) as psychoneuroses (neuroses) or psychoses (insanities). All of the psychoneuroses are believed to be functional. Some psychoses are classified as "functional" and some as "organic." Functional disorders are, in the present state of our knowledge, attributed primarily to the mode of living and thinking acquired by the individual. The personality disorders said to be "organic" involve recognizable damage within the nervous system, and especially within the brain.

Examples of psychoneurotic disorders are: bodily complaints, indecision and doubts, some symptoms of dissociation (including multiple personality), and anxiety states. Psychoanalysis and client-centered and group therapy are often used to alleviate psychoneurotic disorders. Tranquilizers are also used.

Examples of psychoses with known organic damage are: general paresis, senile psychosis, and alcoholic psychosis. The so-called "functional psychoses" are manic-depressive psychosis and schizophrenia, or dementia praecox. There is still much discussion as to whether schizophrenia has organic bases. Four types (simple, hebephrenic, catatonic, and paranoid) are included in most classifications. Mixed types are also recognized.

Although our survey of psychoses was primarily to show the kinds of personality disorders that occur, we mentioned briefly some of the possible origins and some forms of therapy, including group therapy, shock therapy (electric and insulin), tranquilizers, and psychosurgery.

Mental hygiene is concerned with the prevention of mental illness in all of its forms. It works through such channels as parent edu-

cation and the establishment of clinics for the treatment of personality disorders before they

become so serious as to require hospitalization.

(References and notes for this chapter are on page 555 of the Appendix.)

## Selected Readings

- Allport, G. W., *Pattern and Growth in Personality*. Holt, Rinehart, and Winston, 1961. A revision of Allport's *Personality* (1937), regarded as a classic in this area. The new presentation "is intended for college students who have little or no background in psychology."
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- Cronbach, L. J., *Essentials of Psychological Testing* (2nd Ed.). Harper, 1960. See Chapters 15-19 for a survey of personality tests.
- Dulaney, D. E., Jr., R. L. DeValois, D. C. Beardslee, and M. R. Winterbottom, *Contributions to Modern Psychology*. Oxford University Press, 1958. Chapter VIII reprints some important papers on the social backgrounds of personality.
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- Hall, C. S., and G. Lindzey, *Theories of Personality*. Wiley, 1957. A comprehensive review of major theories, including the various psychoanalytic theories.
- Harsh, C. M., and H. G. Schrickel, *Personality*. Ronald, 1959. Part II surveys personality tests and also discusses personality theory.
- Shaffer, L. F., and E. J. Shoben, Jr., *The Psychology of Adjustment* (2nd Ed.). Houghton Mifflin, 1956. The various personality tests are discussed in Chapter 11. Chapter 12 is an excellent discussion of organic factors in personality — endocrines, physique, and heredity.
- Weinberg, H., and A. W. Hire, *Case Book in Abnormal Psychology*. Knopf, 1956. Twenty case studies of personality disorder, including most of the kinds discussed in this chapter as well as others.
- White, R. W., *The Abnormal Personality* (2nd Ed.). Ronald, 1956. A good example of how the topic of personality is treated in the field of abnormal psychology.

# The Learning Process

10



Conditioned responses • Pavlov and the salivary response • Bechterev's contribution • Some conditioning phenomena • Instrumental conditioning • Operant conditioning • Acquiring skills • Acquisition of skills in animals and men • Some skills that are typically human • Problem-solving • Learning by imitation • Levels of complexity in habit formation • Transfer • Foundations of learning • The role of motivation • The relative economy of different learning procedures • Some basic conditions for learning • Summary

Any response with which an organism is not endowed by its biological heritage is said to be *acquired*, or *learned*. The term *habit* also applies, as when we said earlier that man is a creature of habit rather than instinct. Instincts, tropisms, and reflexes are part of the biological endowment of organisms which have them, hence we refer to these responses as *unlearned*. Their development in the individual organism is dependent upon maturation rather than learning.

Learning can be defined as *the process of being modified, more or less permanently, by what happens in the world around us, by what we do, or by what we observe*. In preceding chapters and in the above discussion we have referred to many aspects of human life as learned. Examples of learning are actually innumerable. But, for convenience in discussion, it is possible to group them into various classes.

What we learn, first of all, is to make relatively simple responses to the immediate aspects of our environment—to find and suck the nipple when hungry, to cry in order to get picked up, and to withdraw from painful stimuli before they reach us.

This relatively simple learning involves the modification of inborn responses and is often referred to as *conditioned-response learning*.

In early childhood we also learn many *motor skills*, like reaching for and grasping objects, standing up unaided, putting on our clothes, and buttoning or zipping them up. With this sort of acquisition underway, and motor skills of increasing complexity being added to our repertoire, we begin to acquire *verbal skills*. At first there is no more than a limited understanding of what certain words and gestures mean. Then we develop such verbal skills as saying words, combining them to form sentences, and writing them.

While acquiring motor and verbal skills, we are also gaining facility in *problem-solving*. We solve simple problems at first, like finding our way around, extricating ourselves from frustrating situations, and getting others to cooperate with us. Gradually we learn to solve problems that are more complex, including those which involve a high degree of verbalization.

We also acquire *information* about ourselves and the world around us. This facilitates the acquisition of skills and the solution of problems. At times the solution to a problem requires that we pool relevant information — that we “put two and two together.”

Thus there is a gradual transition from simpler forms of learning to the level of problem-solving which takes us into the realm of the thought processes, discussed in Chapter 12.

While we are adding to our repertoire of skills, acquiring useful information, and solving problems of various kinds, we are also *learning how to learn*. Further acquisitions are accordingly facilitated.

The various forms of learning occur concurrently and they are inextricably interwoven and interdependent. Whether there are really different kinds of learning or whether all are reducible to a common principle, like conditioning, remains to be seen.

## CONDITIONED RESPONSES

The term *conditioning* is often used to represent all learning, even that involved when, in the process known as ‘brain-washing,’ a person comes to accept a new concept of his country, or its enemies, or their policies. We deal with conditioning in a much more limited sense. It means for us the acquisition of conditioned responses. Thus the term is used to represent a relatively simple aspect of the learning process. This restricted use does not imply, however, that the principles involved are without wider application. Pavlov himself claimed that “different kinds of habits based on training, education, and discipline of any sort are nothing but a long chain of conditioned reflexes.”<sup>1</sup> We know today that the evidence fails to justify such a sweeping generalization; nevertheless, many psychologists feel that principles involved in the acquisition of conditioned responses play a role in all learning.

The response to be conditioned is already in

the organism’s repertoire. In one type of conditioning procedure, what we do is to associate this response with a stimulus which previously failed to arouse it. Thus, in the experiments of Pavlov, discussed earlier (pp. 22–23) from the standpoint of their influence on behaviorism, the dog which had not previously salivated to a sound came to do so. In Bechterev’s experiments, which were considered in the same connection, the dog lifted its foot in response to a bell or light, whereas, before conditioning, it did this only when shocked on the leg. Although we somewhat oversimplify the situation to say so, conditioning in such instances involves the substitution of a new stimulus — a previously indifferent one — for the stimulus which originally elicited the response. We could also say that the animal learns to make an old response to a new stimulus. Such statements are oversimplified, however, for we will see that the response itself may be modified during the conditioning process.

There are also occasions when the condi-

tioned stimulus leads to the *suppression* of a former response. We see many comparable examples in everyday life. The child reaches for the cookie jar and his mother scowls or tells him not to touch. He continues to reach and gets a spanking. After he has "learned his lesson" the scowl or verbal command is enough to stop him.

Sometimes an investigator does not know what stimuli arouse a particular response, as Pavlov knew that food would produce salivary secretions. Nevertheless, once a response has appeared, its subsequent occurrence may be modified by conditioning procedures. All of us have seen instances of such conditioning. The infant happens to put his thumb in his mouth. Sucking it has satisfying results. Before long he has a thumbsucking habit. And, from the negative standpoint, a child happens to touch the hot stove. The painful consequences of this behavior are such that this response may never recur.

Our preliminary survey of the type of learning to be considered in the following pages has prepared us to delve more deeply into its intricacies.

#### PAVLOV AND THE SALIVARY RESPONSE

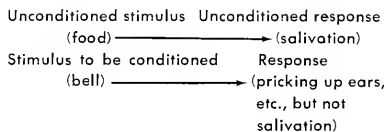
Pavlov's interest in salivary conditioning came out of earlier studies of gastric secretions, for which he received the Nobel Prize. In the course of the earlier research, he observed that saliva and gastric juices are secreted at the sight of food, or even at the sound of the keeper's footsteps. Pavlov at first called these "psychic secretions" to distinguish them from the original ones, which were elicited only when food entered the mouth. This observation was not in itself of great significance, for it had long been known that one's mouth waters at the sound of the dinner bell, or some other indication of approaching food. But Pavlov saw in this reaction a way to investigate the functioning of the brain in a *whole organism*. Before this time it had been customary for neurologists to remove parts of the nervous system and to study the effects of their removal.

It was only after he had done much work on conditioned salivation (see Figure I.8, p. 23), that Pavlov saw the wider implications already

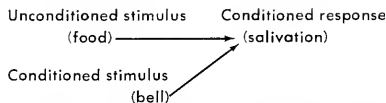
referred to in the statement that all learning is conditioning.

Our basic vocabulary in this area of science originated with Pavlov. Salivation in response to food placed in the mouth is a natural, unlearned response — in short, a reflex. This was called the *unconditioned reflex*. Food was called the *unconditioned stimulus*. When Pavlov's repeated presentation of a bell followed by food led the dog to salivate in response to the bell, he referred to the bell (or any other previously indifferent stimulus) as the *conditional stimulus*. Salivation in response to this was designated a *conditional reflex*. Use of the term *conditional* emphasized the fact that arousal of the reflex was now dependent upon stimuli other than the natural one. In translation, however, the Russian word *ouslovny* became conditioned rather than conditional, hence the widespread adoption of the adjective *conditioned*. Also, it became apparent in later research that many conditioned responses are, strictly speaking, not reflexes. When responses other than salivation are considered, what begins as a reflex may itself change as it becomes conditioned. For this and other reasons, the term conditioned *response* has come into general use.

The conditioning process may be illustrated diagrammatically in such a way as to show the S-R relationships. Thus, before the salivary response is conditioned to a bell, we have the following situation:

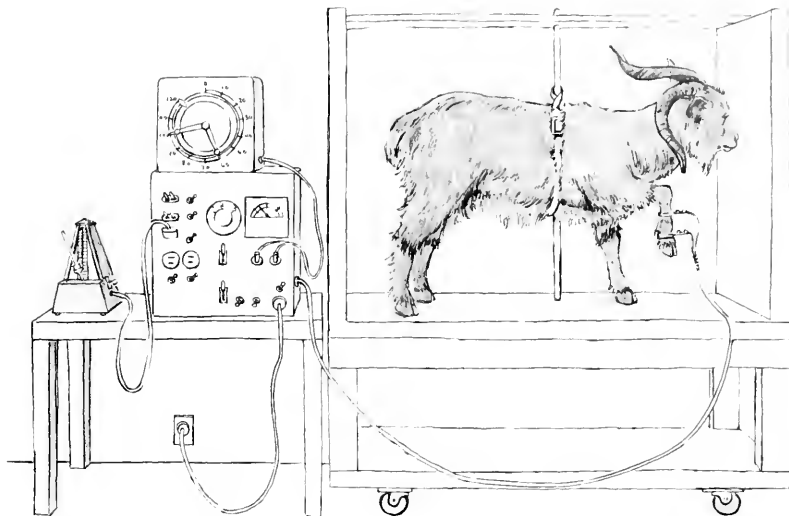


After the stimulus to be conditioned has been paired with the unconditioned stimulus a number of times, and salivation in response to it (now the conditioned stimulus) has developed, the situation is as follows:



The previously neutral or ineffective stimulus, as well as the unconditioned one, now elicits





**10.1** **Bechterev's Method of Conditioning.** This is the arrangement used in research on conditioning at the laboratory of the Cornell University Behavior Farm. A mild electric shock is followed by withdrawal of the goat's right foreleg. The clicking of the metronome does not at first produce this reaction. When the metronome and the shock are presented in close association, and the animal has thus been conditioned, it raises its leg as soon as the metronome sounds. The devices shown are for presenting stimuli and recording responses. (From Liddell, H. S., "Conditioning and Emotions," *Scientific American*, 1954, 49.)

salivation, so we say that salivation elicited by the bell alone is a *conditioned* response.

Pavlov introduced many other terms. One of these — *reinforcement* — is widely used today, although often with a somewhat different meaning than when Pavlov used it. For him, this term referred to the following of the conditioned by the unconditioned stimulus, as when food followed the ringing of the bell. The term *reinforcement* is now also used when reward or punishment follows a particular response; for instance lever-pressing. We use the term *positive reinforcement* for rewarding and *negative reinforcement* for punishing conditions.

#### BECHTEREV'S CONTRIBUTION

Pavlov confined his attention to dogs and, in these, to the salivary response. Bechterev, his

Russian contemporary, who had worked in Wundt's laboratory at Leipzig, extended the conditioned-response technique to human beings.<sup>2</sup> In his work with dogs and human subjects, Bechterev used an electric shock as the unconditioned stimulus and reflex withdrawal of the shocked limb as the unconditioned response. Many different kinds of conditioned stimuli were used, including the beating of a metronome, as in Figure 10.1, which shows Bechterev's method applied to a goat.

Observe that the subject conditioned with this method gets the shock whether or not it responds to the conditioned stimulus. Bechterev called the response to the new stimulus an "associative reflex," but later workers with this and related methods have adopted Pavlov's terminology.

The general procedures used by Pavlov and Bechterev have been extended to other re-

sponses than those conditioned by them and also to a wide range of organisms. These procedures are frequently referred to today as *classical conditioning*, partly in deference to the pioneer investigators and partly to distinguish them from other research in which a reward element is introduced; research in which, for example, the subject escapes the shock if it makes an anticipatory response, or gets a pellet of food if it presses a lever. These procedures are generally referred to as *instrumental conditioning* because the subject's response is instrumental in allowing it to escape pain or to obtain a reward.<sup>3</sup> When an instrumental response is initially a spontaneous one rather than being elicited by an unconditioned stimulus, it is said to be an *operant* and this type of instrumental conditioning is referred to more specifically as *operant conditioning*, as detailed later in this chapter.

### SOME CONDITIONING PHENOMENA

The various phenomena which now receive our attention were revealed in experiments on classical conditioning. Many were first discovered by Pavlov and Bechterev, then verified in comparable experiments utilizing a wide variety of responses in various animal subjects and human beings. Later, when instrumental conditioning is discussed, we will observe that some of the principles worked out with classical procedures also apply to instrumental conditioning.

#### Sequences and time relations

In research with classical procedures, the conditioned stimulus has usually preceded the onset of the unconditioned stimulus, or it has been presented at the same time as the latter. The reverse order—unconditioned stimulus first—sometimes produces conditioning, but this is very difficult to obtain. When it occurs, we call it *backward conditioning*.

The most effective procedure is to present the conditioned stimulus first. But how much earlier should it occur? This is perhaps a question which cannot be answered for every organism and for every possible conditioning situation. Nevertheless, several experiments have suggested that the optimum interval may be somewhere around one-half second.<sup>4</sup>

#### Changes in the response conditioned

Upon superficial observation, as we said earlier, it appears that conditioning is merely the arousal of an old response by a new stimulus. This seems to be so in salivary conditioning. However, some differences between the conditioned and the unconditioned response are much more evident in withdrawal than in salivation.

The dog given a shock on the foot at first barks, struggles, and withdraws its foot. No doubt the pulse, respiration, blood pressure and other physiological reactions are affected. If we were looking for it, we would find conditioning of any of these.<sup>5</sup> But our attention is on overt behavior, especially foot withdrawal. The responses described are at first aroused only by shock. After a bell, say, has preceded the shock a number of times, there are quite evident alterations in behavior. We observe that the dog becomes agitated even before being shocked. It acts as if it were expecting the shock. It struggles and withdraws one foot after another. These are anticipatory responses. As conditioning proceeds, we observe further changes. Much of the initial excitement disappears. That is to say, the dog becomes adapted to the situation. Finally, as the bell goes on, the animal may, with seeming nonchalance, lift its foot and do nothing else. What was at first a generalized reaction, involving the whole organism in an obvious way, is narrowed so that only the foot withdrawal occurs.<sup>6</sup> Similarly, when respiration is being conditioned to a tone, the tone may come to produce a slight (anticipatory) change in respiration. This is followed, when the shock comes on, by a respiratory change of greater magnitude.

Thus the conditioning procedure may have several effects. It may produce conditioned adaptation to the situation, it may produce an attitude of expectancy, it may produce an overt anticipatory response which is sometimes an abbreviated form of the response we are conditioning, and, finally, it may produce a more restricted response to the conditioned stimulus than the reflex originally elicited. For these reasons, it is an oversimplification to say that the conditioned response is merely an old response to a new stimulus or that conditioning is no more than substituting a new stimulus for the natural one.

## Stimulus generalization

In the chapter on emotion we discussed a child who, when conditioned to fear a white rat, became afraid, also, of such hitherto neutral objects as a rabbit and a white beard (see Figure 7.16, p. 196). Fear was generalized from the original stimulus to other stimuli which resembled it. In the same way a child who is frightened by one dog may show fear of other dogs.

Pavlov attributed stimulus generalization to a spread of effects from the region stimulated to other parts of the organism, especially to other parts of the brain than those primarily excited. He referred to the phenomenon as *irradiation of excitation*.

## Differential conditioning

An organism conditioned to respond to a light, a tone, or an odor usually also responds to other visual, auditory, and olfactory stimuli. Stimulus generalization occurs. But presentation of several stimuli in the particular class, and reinforcement of only one, may produce discrimination between them.

Differential conditioned reflexes provide us with an important tool for analysis of sensory stimulation. Animals and infants cannot tell us what they sense, but their differential conditioned reactions tell the story just as well as words could tell it. If we wish to know how small a difference in loudness a dog can discriminate, for example, we condition its withdrawal response to a certain intensity of stimulation and not to another widely different intensity. The latter is presented frequently, but not reinforced. After the animal withdraws its foot for one sound and not for another, we gradually reduce the difference in loudness. The smallest difference to which it responds is thus determined.

## Experimental extinction and recovery

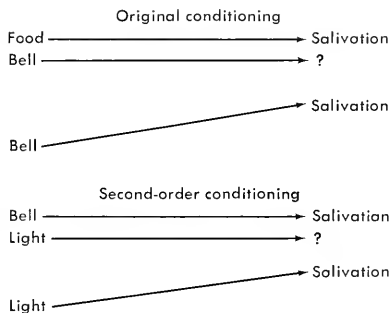
Once a conditioned response has been formed, how may it be eliminated? Sometimes alternative responses are learned. Thus the child who withdraws from a feared white rat may learn to overcome its fear by feeding the rat. The method most widely used to extinguish a conditioned response is, however, to present the conditioned stimulus repeatedly

without reinforcing it — without following it with the unconditioned stimulus. Thus, if the bell that has been eliciting a salivary response is rung without presentation of food, the amount of saliva decreases gradually. Finally, there is no salivation in response to the conditioned stimulus.

An experimentally extinguished response usually returns, a phenomenon known as *spontaneous recovery*. Continually extinguishing a conditioned response, however, produces a gradually decreasing spontaneous recovery. Finally, the response fails to return.

## Higher-order conditioning

Pavlov found that, once conditioning was well established, he could use the conditioned stimulus as the “unconditioned” stimulus for further conditioning. That is to say, if the animal had been conditioned to salivate in response to a bell, Pavlov could now use the bell instead of food to obtain further conditioning. The situation is as follows:



Pavlov failed to obtain higher than second-order conditioning in dogs, but he believed that there is no discoverable limit to the orders of conditioned responses which man acquires under conditions of everyday life.

Development of a second-order conditioned response is difficult in the laboratory, because experimental extinction occurs. The bell, for example, must be reinforced frequently with food so that salivation to it does not extinguish while it is being used as the “unconditioned” stimulus.

## INSTRUMENTAL CONDITIONING

So-called "instrumental conditioning" is similar to the "classical" variety in certain respects and different from it in others. Some psychologists regard the two as essentially alike and others as essentially different.<sup>7</sup>

One major point of similarity is that, in both instances, the animal is customarily isolated from the environment at large. It is placed in a soundproofed room or box so that what one investigator calls the "background racket," or "background noise of stimulation" is reduced to a minimum. Another similarity is that some particular response is, as it were, isolated for study.

The main points of difference are three. (1) Whereas classical procedures use an unconditioned stimulus (such as food or shock, a puff of air) to elicit a response to be conditioned, the instrumental procedure does not necessarily do this. The response conditioned, especially in a variation of the instrumental procedure known as *operant conditioning*, is not a response to experimentally controlled stimulation but rather an apparently spontaneous one. This response, lever-pressing for example, is *emitted* by the animal rather than elicited by the experimenter. (2) In the instrumental procedure, as its name implies, the animal's response is instrumental in achieving some result, whether this be access to food, or water, or, on the other hand, escape from punishment, or confinement. (3) In the operant type of instrumental conditioning, the animal is given more freedom than when classical procedures are used. Rather than being strapped in a conditioning frame, it is free to move around in a box or other enclosure.

What has been called *avoidance conditioning* involves a combination of the features of classical and instrumental conditioning. It is like Bechterev's method in that electric shock is used to elicit a certain class of reactions, such as avoidance or fear. There is also a conditioned stimulus which signals the coming of the shock. This may be any sort of stimulus that the animal can sense—light, metronome, or tone. The instrumental feature is introduced by arranging the situation so that, instead of getting the shock regardless of what it does, the subject can react in such a way as to avoid being shocked. Avoidance is pos-

sible if it responds to the conditioned stimulus in time—i.e., makes an anticipatory response. If the goat in Figure 10.1 were being conditioned by an instrumental procedure, one electrode would be under its foot so that, when anticipatory withdrawal occurred, this would break the circuit.

Sometimes the animal subjected to avoidance training has much more freedom than Bechterev's subjects. Dogs and other animals have been placed in an enclosure, the floor of which can be electrified. A light, let us say, signals that a shock is to come. The situation may be arranged so that, if the animal does anything at all when the light comes on, the shock is turned off. Sometimes the subject is required to do some specific thing as the conditioned stimulus comes on—for example, turn a revolving drum<sup>8</sup> or jump over a barrier to the nonelectrified side of an enclosure.<sup>9</sup>

Experiments have been done to compare the relative effectiveness of classical and instrumental procedures. Of two comparable groups, one gets the shock regardless of what it does (classical) and the other avoids the shock if it makes an anticipatory response (instrumental). Conditioning is obtained with either. But, surprising as it may seem, the instrumental procedure is not always more efficient than the classical. One reason for this may be that, after the animal avoids the shock a few times, there is a tendency for experimental extinction to occur.<sup>10</sup>

## OPERANT CONDITIONING

This gets its name from the fact that in order to get a reward the organism does something to its environment. To quote Skinner, who coined the term *operant*, it "emphasizes the fact that the behavior *operates* upon the environment to generate consequences."<sup>11</sup> These consequences are the coming of food, water, or some other reward. The response which operates upon the environment as described is called an *operant*. A term commonly used to represent the reward in operant conditioning is *reinforcement*. This term, as we said earlier, was taken over from Pavlov who, however, used it in a more restricted sense. Again we quote Skinner: "Pavlov himself called all events which strength-

## 10.2 Operant Conditioning Box for Mice.

By pressing the lever, the mouse gets a small pellet of food. It can get water at any time through the tube seen below the bottle at the left. The apparatus in the other compartment can be arranged to yield pellets in accordance with particular schedules of reinforcement, as described in the text. It also contains connections through which responses are recorded on a moving tape. (Anliker, James and Jean Mayer. "An Operant Conditioning Technique for Studying Feeding-Fasting Patterns in Normal and Obese Mice," *Journal of Applied Physiology*, Vol. 8, No. 6, May, 1956.)



ened behavior 'reinforcement' and all the resulting changes 'conditioning.' In the Pavlovian experiment, however, a reinforcer is paired with a *stimulus*; whereas in operant behavior it is contingent upon a *response*.<sup>12</sup> This response is *emitted* by the animal.

The investigator usually decides beforehand which of many responses that may be emitted will be reinforced. For example, one investigator decided that he would let a cat escape from a box whenever it scratched its ear.<sup>13</sup> Eventually it scratched, the door opened, and it got out. In subsequent trials, ear-scratching was not so long in coming. Finally, as soon as it was placed in the box, the cat scratched its ear. In another cat, licking was reinforced. A chicken was similarly conditioned. When it pecked its feathers, the door opened. Finally, he would "whirl his head around and poke into his feathers as soon as dropped into the box."

As techniques of operant conditioning are discussed, it will become very evident that the psychologist has here a powerful means of controlling behavior. By using these techniques, he can increase the frequency of one response and reduce that of others. He can also shape behavior in other ways. Wanting the organism to respond in a certain manner he can arrange to reinforce one response and not others so that behavior increasingly approxi-

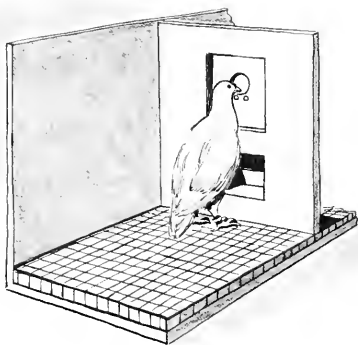
mates the desired form. This is what we mean by "shaping" an organism's behavior. Its significance will be clearer as we proceed. We will also observe its application to human beings.

### Operant conditioning techniques

The above experiments show what is meant by reinforcing an operant but they hardly do justice to the techniques of operant conditioning as these are typically used.

In the typical research situation an apparatus like that of Figure 10.2 is used for rats, mice, hamsters, and other animals for which lever-pressing is an easily acquired response. Essentially the same technique has been adapted for use with monkeys, chimpanzees, and children. One such adaptation was shown (p. 215) when we discussed ulcer formation in "executive" monkeys. Much of the recent research has used pigeons. These peck a disc (Figure 10.3) instead of pressing a lever.

We see in the lever-pressing and disc-pecking situations an interesting contrast with classical conditioning. As we have already indicated, the latter arouses the response to be conditioned by using an unconditioned stimulus. In operant conditioning, on the other hand, nobody can identify the stimulation responsible for the response to be conditioned.



### 10.3 Operant Conditioning Box for Pigeons.

The operant here is pecking the disc. Reinforcement comes from a piece of food which falls into the aperture below. (From Ferster, C. B., and B. F. Skinner, *Schedules of Reinforcement*. Copyright, 1957, Appleton-Century-Crafts, Inc.)

This is evident from what has already been said about this response being *emitted* by the animal. Nevertheless, if the situation contains a lever to be pressed, and lever-pressing is the only response reinforced, it is evident that the subject will eventually be lever-pressing rather than doing something else. But, one may ask, "If an investigator knows enough to arrange a situation in which a particular response like lever-pressing or disc-pecking will occur, and he verifies his prediction, what more is there to know — where does one go from there?" The answer is that the establishment of a predictable response is only a first step. Once this response has been established, the investigator uses it as a "tool" with which to investigate the effect of various conditions upon the organism — variations in reinforcement, changing internal physiological conditions, brain disturbances, and so forth.

The most important feature of operant conditioning, once the response has been acquired, is *rate of responding*, the number of responses per minute. Investigations like those mentioned are focused upon conditions which influence response rate. Every response is recorded automatically (Figure 10.4). In addition

to recording responses automatically, the apparatus shown at the rear of the box in Figure 10.2 provides automatic reinforcement.

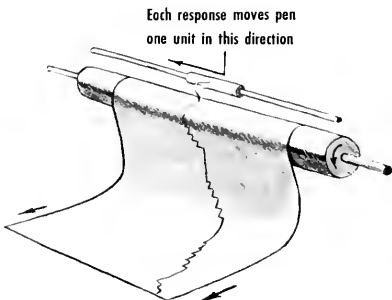
In typical research on operant conditioning, reinforcement is provided by a small piece of food. This is an instance of *reward training*. In some studies, however, the floor of the apparatus is electrified and the subject's response turns off the shock. In this event we refer to *escape training*.

#### Reward training

A hungry rat discovers that pressing a lever will bring food. After a few repetitions, sometimes with a more or less lengthy interval between, it presses at a faster rate. A typical acquisition curve of this nature is reproduced in Figure 10.5. The rat pressed the lever soon after being placed in the box but did not repeat this response until almost an hour later. After another 50 minutes, the lever was pressed again. This was repeated about 25 minutes later. Then, as if the animal had at last "caught on," it began pressing at a fast rate. Toward the end of the record shown here, responses

### 10.4 Diagram of a Cumulative Recorder.

Here we see how, every time the rat presses the lever or the pigeon pecks the disc, it records its own response and, in the long run, makes its own acquisition curve. The roller is activated by electric clockwork so that it moves the paper continuously and at a constant rate of speed. (From Ferster, C. B., and B. F. Skinner, *Schedules of Reinforcement*, Copyright, 1957, Appleton-Century-Crafts, Inc.)





**10.5 Acquisition of a Lever-Pressing Response by a Rat.** Every response, shown by a rise in the level of the curve, was followed by the dropping of a pellet of food. The first three reinforcements were apparently ineffective, but the fourth was followed by a rapid increase in rate of lever-pressing. (From Skinner, B. F., *The Behavior of Organisms*. Copyright, 1938, D. Appleton-Century-Crofts, Inc.)

were coming only 10 seconds apart. Finally the curve flattened, possibly because the rat had become satiated.

#### Schedules of reinforcement

Much learning that occurs in everyday life is reinforced intermittently rather than continuously. This is also true of subsequent performance of what has been learned. Considerable interest therefore attaches to the study of what can be accomplished with different schedules of reinforcement.

The device which controls food delivery can be set so that reinforcement occurs after every response or so that it occurs intermittently. In the latter event, there may be reinforcement at *fixed intervals* (let us say, every ten minutes), at *fixed ratios* (as when one reinforcement comes after every tenth response), or at *variable intervals* or *variable ratios*. The rate of responding varies in predictable ways as the schedule of reinforcement is varied. A large volume containing almost 1000 curves obtained with pigeons deals in detail with such relationships.<sup>14</sup>

In general, each reinforcement after a fixed interval is followed by a slow rate of responding. But the rate picks up as the time for the next reinforcement approaches. An animal's reactions show, in fact, that it discriminates the time interval between reinforcements.

With fixed-ratio reinforcement, the subject gets so much per unit of work. This is like piecework in industry. With this type of schedule, there is an extremely high rate of responding just so long as the animal need not work too long for each reinforcement. With a ratio of reinforcement that is conducive to a high overall rate of responding, there is, as in the case of fixed-interval reinforcement, a lag just after each payoff. The rate falls, then picks up.

With both interval and ratio reinforcement, it is possible to maintain a consistently high response rate by varying the interval or ratio around some middle value. Under these circumstances the animal cannot learn exactly when the reinforcement will come, and it therefore cannot adjust to any fixed interval or make any particular series of responses with expectancy of a reward. Several responses in succession may be reinforced, then there may be no further reinforcement for ten responses, the next may be reinforced, then not another until five have occurred, and so it goes. When subjected to such a schedule, pigeons have responded for many hours at as fast a rate as five pecks per second. Skinner points out that

The efficacy of such schedules in generating high rates has long been known to the proprietors of gambling establishments. Slot machines, roulette wheels, dice cages, horse races, and so on, pay off on a schedule of variable-ratio reinforcement. Each device has its own auxiliary reinforcements, but the schedule is the important characteristic. Winning depends upon placing a bet and in the long run upon the number of bets placed, but no particular payoff can be predicted. The ratio is varied by any one of several "random" systems. The pathological gambler exemplifies the result. Like the pigeon with its five responses per second for many hours, he is the victim of an unpredictable contingency of reinforcement.<sup>15</sup>

#### Extinction

In classical conditioning, the response weakens and disappears when the unconditioned stimulus does not reinforce it. Something comparable occurs in operant reward-training. While reinforcement does not need to fol-

low each response, the rate of responding drops whenever reinforcement is consistently absent. Extinction rates vary with motivational and other conditions, complete absence of reinforcement is followed, eventually, by extinction of the response. As in the case of classical conditioning, however, there may be spontaneous recovery when, after an interval, the animal is returned to the situation in which it was conditioned.

### Secondary reinforcement

Material rewards, such as food for the hungry animal, are providers of *primary reinforcement*. However, reinforcement also comes from things which do not reduce a drive directly (as food reduces hunger). The sight of food precedes food in the mouth, hence *seeing* food may come to have a certain degree of rewarding value in its own right. We then say that it is a secondary reinforcer, or that it provides *secondary reinforcement*.

Many stimuli, through their association with primary reinforcers, come to have a reward value. Pavlov observed this fact and we have already discussed it as an example of second-order conditioning. There, a bell which was used in conditioning the salivary response could later be used, in place of food, to condition a response to some other stimulus—in our example (p. 275), a light. The same principle holds for operant reward-training. The mechanism that delivers food pellets may be designed so that a click occurs every time a pellet is dispensed. After this has occurred a number of times, the click itself may reinforce lever-pressing. Evidence comes from observations like the following: The response is conditioned with click and food pellet until it is occurring at a fast rate. If both the food and the click are withheld, a typical extinction curve is obtained. But if food alone is withdrawn, extinction either fails to occur or it is much slower than under conditions when no click is used.<sup>16</sup>

Another illustration of secondary reinforcement comes from chimpanzees. These animals learned to operate a "work machine" which, after so much work, produced a grape and an associated poker chip. Later in the experiment, they worked for poker chips (token-rewards) alone.<sup>17</sup>

Secondary reinforcers are themselves subject to experimental extinction. That is to say, unless primary reinforcement is occasionally associated with them, they gradually lose their effectiveness. Thus food must be eaten as well as seen, clicks must sometimes again be associated with food, and poker chips must purchase grapes, as in the "chimp-o-mat" (Figure 10.6).

Many other examples of the effectiveness of secondary reinforcement could be given, but the following are representative. A clicking sound associated with food was later used by itself to develop discriminatory responses in pigeons and other animals.<sup>18</sup> When the pigeon pecked at a playing card with diamonds, the click sounded. When it pecked at a card with clubs, there was no click. On this basis it came to peck at one card and not the other. The investigator points out, in fact, that such a secondary reinforcer may be more effective than food because it "rewards" the animal immediately after the correct response occurs. A food reward would involve more delay, hence slower learning. The poker chips already referred to were also used, by themselves, to reinforce responses learned by chimpanzees.<sup>19</sup>

Secondary reinforcers are extremely potent in the control of human learning. Money, which corresponds in a way to the token rewards used with chimpanzees, is a form of secondary reinforcement. But gestures and words are also reinforcing. A smile, a pat on the back, the words "good girl" or "big boy," the statement "correct" or the mark "A plus" are all positive reinforcers when used appropriately.

Even the simple expression "Mmm-hmm" made after a verbal response may reinforce that response. For example, fifteen students, worked with individually, were asked to say as many words as possible until stopped by the investigator. Whenever they said a plural noun the experimenter said "Mmm-hmm." A matched control group spoke without any word being reinforced. Initially, both groups gave an equal number of plural words. But by the end of twenty-five minutes, the verbally reinforced group had given almost twice as many plural words as the control group. Reinforcement was then withdrawn. Gradually thereafter the number of plural words in the previously reinforced group approached the num-



**10.6** Using a Poker Chip to "Purchase" a Grape at the Chimp-o-mat. The chimpanzees earned their chips by hard work at the work machine — which required that they repeatedly lift a heavy lever. At first they received a grape. Then poker chips served as secondary reinforcement. Sometimes there was a day's delay before the chips could be spent, yet the animals accumulated a large number of chips. Some animals also learned to differentiate between chips of different value — white, one grape; blue, two grapes; red, a drink of water; and yellow, return to the home cage. (J. B. Wolfe, 17. Photo courtesy Yerkes Institute of Primate Psychobiology.)



ber being given by the control group. Only one subject realized that the experimenter was attempting to shape his behavior. The results for this subject were of course discarded.<sup>20</sup>

Another experiment of a somewhat comparable nature was designed to see whether verbal reinforcement could be used to increase the frequency of opinion statements. Each opinion expressed during a protracted conversation was reinforced either by the experimenters' agreeing with it or paraphrasing it. Thus, when the subject said such things as "I think . . .," "I believe . . .," "I feel . . .," or "it seems to me. . .," the experimenter would say, for example, "You're right," "I agree," "That's so." Or he would say something like this: "What you are saying is that. . . ." The experimenters were psychology students working with other students. Although there were twenty-four subjects, not one realized that he was being used as a "guinea pig." The effect of agreement or paraphrasing was decidedly positive. A ten-minute period preceding, and a comparable period following ten minutes of reinforcement provided control data. In every subject, the ten-minute reinforcement period produced more opinion statements than either of the control periods.<sup>21</sup>

#### Successive approximations

Reinforcement of responses which successively approximate desired performance is worthy of special attention because, through it, the experimenter can shape the animal's behavior. We have learned that any response which precedes reinforcement sufficiently often will tend to increase in frequency. Suppose, now, that we want a pigeon to peck a disc. It will perhaps do this after pecking one part of the experimental box after another. But suppose that we wish to shorten the process. As the pigeon moves closer to the disc, we reinforce it (with food or a secondary reinforcer such as a click). No further reinforcement occurs until the pigeon gets closer still. Gradually, in this way, the bird is brought to the wall with the disc. Now it receives no further reinforcement until it pecks the wall. Next it must peck closer to the disc before it is reinforced. Finally, in this way, the bird's behavior is shaped so that it is pecking the disc. Thereafter, every peck is rewarded and disc-pecking grows in frequency.<sup>22</sup>

By utilizing operant reward-training, including the procedure of reinforcing successive approximations, entertainers have taught animals

to perform remarkable tricks in a very short time. Many readers have no doubt seen these acts at county fairs and on TV. How they are produced has been described by two people, who credit Skinner and operant conditioning for their successful career as animal trainers.<sup>23</sup>

### Escape training

Escape training differs from avoidance training (p. 276) in certain respects. The latter utilizes a stimulus to signal the onset of punishment. As the subject learns the significance of this signal, it makes anticipatory responses which enable it to avoid punishment. In escape training, on the other hand, the floor of the cage may be electrified so that the animal is continually punished until it finds a way to turn off the current. This it may do by pressing a lever (Figure 8.10, p. 224), by turning a wheel, or by some other action decided upon beforehand by the investigator. Under these circumstances, the subject usually exhibits a lot of seemingly random behavior during the course of which it makes the proper response. Subsequently, this response occurs with decreasing delay. Finally, as soon as the shock comes, the animal turns it off.<sup>24</sup>

## OPERANT CONDITIONING IN EDUCATION

The principles of operant conditioning may be applied to such problems as teaching arithmetic, spelling, and other subjects, including psychology. One of Skinner's teaching machines is shown in Figure 10.7. Carefully prepared sets of frames are presented serially. The learner makes a response to the first frame and is positively or negatively reinforced. Positive reinforcement comes from finding that his response is correct. He does not make the next step unless this is so. We cannot describe these teaching techniques in detail, nor argue their pros and cons, but it is fitting that we quote Skinner on what his machines are designed to do, and how they accomplish it.

Like a good tutor the machine presents just that material for which the student is ready. It asks him to take only that step which he is at the moment best equipped and likely to take. Like a skillful tutor the machine helps the student to come up with the right answer. It does this in part through the orderly construction of the program and in part with techniques of hinting, prompting, suggesting, and so on, derived from the analysis of verbal be-



**10.7 Student at Work on a Teaching Machine.** "One frame of material is partly visible in the left-hand window. The student writes his response on a strip of paper exposed at the right. He then lifts a lever with his left hand, advancing his written response under a transparent cover and uncovering the correct response in the upper corner of the frame. If he is right, he moves the lever to the right, punching a hole alongside the response he has called right and altering the machine so that that frame will not appear again when he goes through the series a second time. A new frame appears when the lever is returned to its starting position." (Courtesy Dr. B. F. Skinner.)

havior.<sup>o</sup> Lastly, of course, the machine, like the private tutor, reinforces the student for every correct response, using this immediate feedback not only to shape his behavior most efficiently but to maintain its strength in a manner which the layman would describe as "holding the student's interest."<sup>25</sup>

### ACQUIRING SKILLS

Skill is proficiency in the performance of some task. The task may be speaking, typing, playing a musical instrument, driving a car, flying a plane, hitting a moving target, sending and receiving coded messages, reciting a poem, playing bridge, or using the procedures of some art or science.

Some skills are called sensorimotor (or perceptual-motor) because the activities involved are quite obviously dependent upon information provided by sense organs. The batter, for example, swings as he sees the ball reach a certain position and the hunter's aim varies as his target moves. In skills there is, in fact, a constant feedback of information, not only from the external receptors but also from others within the body.

Verbal skills are those in which language activities predominate. One of the purest examples is reciting a poem or a lesson. Although we say that these are "verbal" skills they obviously include sensorimotor functions. One speaks with his vocal musculature and, as we shall see later, perhaps to some extent thinks with it. Verbalization as a "motor" skill is given brief consideration in this chapter.

While it is observing and otherwise responding to its environment, an organism may acquire potentially useful information. But whether or not this results in skilled performance depends upon motivating conditions. Thus hungry rats allowed to explore a maze, but finding no food in it, perform very inefficiently. There is little or no evidence that they have learned anything. Yet, when a food reward is introduced, their performance sometimes shows an unusually rapid improvement — a much more rapid improvement than occurs in the performance of rewarded rats which

are new to the situation. We therefore infer that, during their exploration, the animals were learning something, more or less incidentally, which their earlier performance failed to indicate.<sup>26</sup>

### ACQUISITION OF SKILL IN ANIMALS AND MEN

The chief reason for acquiring any skill is to correct some inadequacy of adjustment. As long as the situation is optimal — as long as it provides ready satisfaction of every need — the organism tends to stay in a rut. Thus, if we want the rat to acquire a skill, we make it hungry and give food as a reward for achievement. In the case of a child, we let it know that there is candy, or money, or praise for accomplishment.

In research on animal learning the subject's method of satisfying a drive is ordinarily disrupted in some way. For example, it can no longer get food in the accustomed place. By using suitable rewards or punishments, we then induce it to acquire the skills necessary for readjustment.

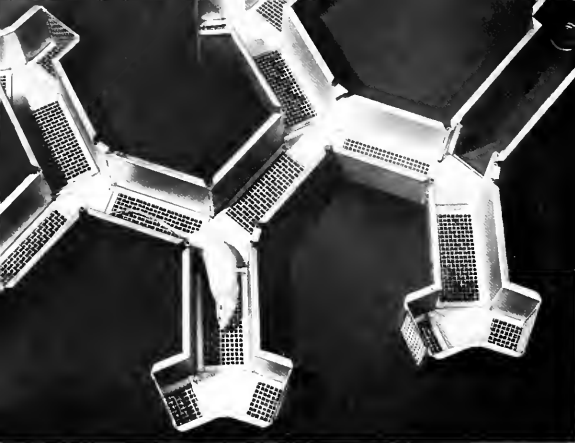
#### Maze learning

Some comparative results on maze learning were described in Chapter 4 (pp. 79–82). Our interest there was in the evolution of intelligence.

One type of maze used with rats is illustrated in Figure 10.8. In the usual experiment, each rat is deprived of food for twenty-four hours prior to a run, or *trial*. Food is obtained only by going through the maze pathway from beginning to end. It is reached most expeditiously by avoiding blind alleys.

When a rat first enters the maze, there may be many apparently random or so-called "trial-and-error" activities. The new environment may be explored more or less thoroughly. Blind alleys as well as units leading more directly to the food may be entered and re-entered. But when food is reached, the trial ends. A record is kept of the number of errors made, the time taken to get from entrance to food box and, if the rat's route has been traced, the excess distance traveled. After the subject eats, it is returned to its cage where the rest of its daily food allowance is available.

<sup>o</sup> Skinner, B. F., *Verbal Behavior*. Appleton-Century-Crofts, 1957.



## 10.8 Maze Learning in Animals.

This is one of many types of maze and maze patterns used to study animal learning. The animal, in this case a white rat, learns to go by the shortest route from the entrance (left) to the food box (right). An error (blind-alley entrance) is shown. Mazes used to study human learning are similar, in principle, to those used with animals. (This is the Warden Y-maze. Photo by Lila Hess, Three Lions, Inc.)

This is usually a small amount which is quickly consumed. The next day, at the same time and under the same motivational and external conditions, another trial is given. Errors, time, and distance traveled are recorded as before. This procedure continues until the maze is run from entrance to food box without error. Usually we say that the habit has been learned when there are no errors on three successive days. The "criterion of learning" here is three errorless runs.

Human mazes take many forms. Sometimes a very large one is used, with high walls that put the subject in much the same predicament as a rat. In a stylus pattern, shown in Figure 10.9, the subject, while blindfolded, traces the groove with a stylus or pencil point.

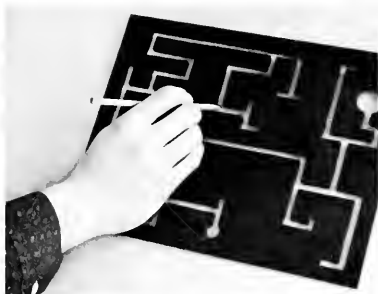
Human mazes are sometimes printed and the subject traces the pathway with a pencil. However, these maze patterns are so complicated that, even though the subject can see the whole layout, his intelligence is put to the test in finding the correct path. He may start tracing with a pencil, and retrace wherever necessary, until the goal is reached. But this is not the characteristic approach. Learning of printed mazes (see p. 81) is likely to be observational rather than manual. The subject looks the situation over and, with his eyes, follows one possible lead after another. When the correct pathway is evident, he then takes pencil in hand and traces it. Trial-and-error is involved here, as in other forms of maze learn-

ing, but it is likely to be implicit more than overt. The individual may *think* his way through.

### Acquisition of the maze habit

Acquisition of any habit may be represented by a learning curve. This shows, at a glance, the general trend of the learning process. Trials are represented along the base (abscissa). Errors, time, correct responses, or other aspects of behavior are represented at the left side (ordinate) of the graph.

Figure 10.10 shows the progress made by rats, children, and adults in learning a somewhat comparable maze. Note that the curves fall as a function of practice. In a situation where correct responses were recorded, the learning curves would rise. Note, also, that the curves approach a limit beyond which performance could not improve. This is the *physiological limit*. In the case of errors and distance traveled, it is set by the problem itself. The subject cannot better a score of no errors, nor can he cover a shorter distance than the shortest route from entrance to exit. In the case of time scores, the physiological limit is approached as a subject gets to the point where he cannot move any faster. When correct responses are plotted, the physiological limit is again set by the problem. One obviously cannot exceed the maximum number of correct turns, or choices. If it were a memory



**10.9 A Stylus Maze.** This is a maze designed by Foster and Tinker. The subject is blindfolded. The maze is traced from the start to the end with a pencil or stylus.

experiment with twenty items to be recalled in correct order, the physiological limit which the learning curve approached would be twenty correct responses.

In some learning curves we see progress up to a point, no further progress for several trials, then further improvement. In this event, the flat place in the curve is referred to as a *plateau*. What seems to be the physiological limit for a particular subject is, in reality, often a plateau, but we cannot be sure unless there is subsequent improvement. This might come about because of increased motivation. It might appear, for instance, that a rat is running the maze as fast as possible — the time curve has flattened out at a certain level. But if we make him more hungry, or give him a shock when he slows down, he may increase his speed.

Individual learning curves often fluctuate a great deal. The subject progresses for a trial or two, regresses or enters a plateau, then shows further progress. For comparative purposes, therefore, individual data are usually combined and averaged to produce a group learning curve. The curves in Figure 10.10 are group curves. Being relatively smooth, they show the general trend and thus facilitate comparisons; in this instance between rats, children, and adults. Note, too, that different indices of efficiency are here combined and weighted, thus producing a smoother curve

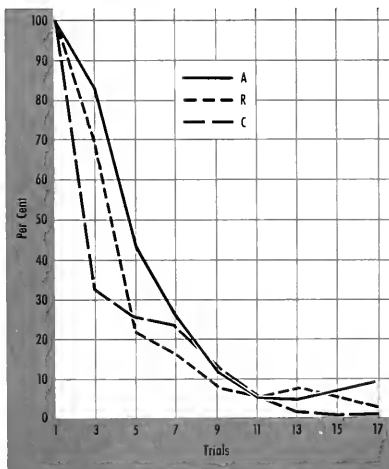
than would come from plotting the average errors and average time scores separately.

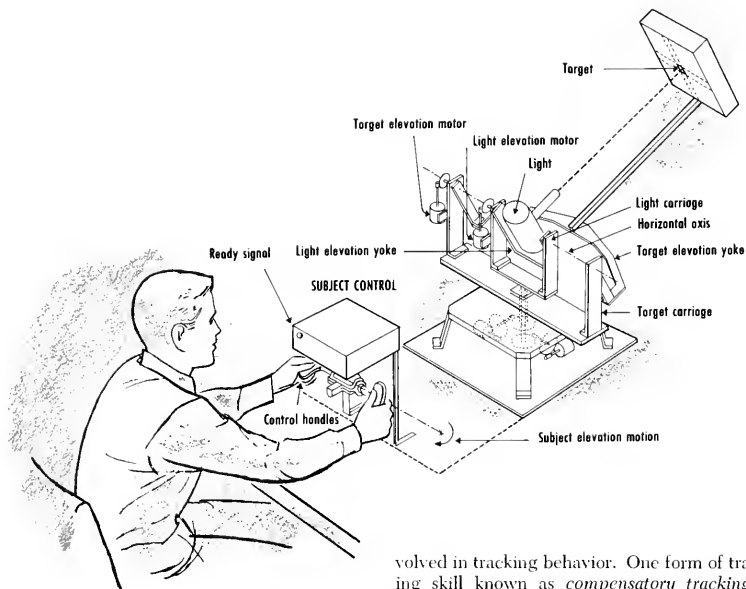
The three learning curves do not differ a great deal. Children at first improve faster than either the rats or adults. The overall trend and the end result, however, are similar for all groups.

#### SOME SKILLS THAT ARE TYPICALLY HUMAN

Mazes are very useful in research on the fundamentals of learning, but many investi-

**10.10 Curves for Maze Learning in Rats, Children, and Human Adults.** The maze was a large one through which the individuals walked. Rats learned a maze which was different from, yet somewhat comparable with, that used for human subjects. A, adults; C, children; R, white rats. The curves are based upon error elimination, reduction in time, and reduction in distance traveled, these three factors being combined. Furthermore, improvement is shown as the percentage reduction of the scores manifested on the first trial. Each point in the curve except for the first, comprises the average of two trials. (After Hicks and Carr.)





**10.11 Pursuit Tracking.** The subject tries to keep the spot of light on the moving target. This simulates many skills required today in military activities. (From Miles, G. H., and D. Lewis, 27, pp. 569, 571.)

gators, and especially those with practical rather than theoretical interests, are more interested in activities that are typically human. At the turn of the century, some were already studying how individuals learn to receive and send telegraph messages and how they learn to type. Later there were studies of how novices learn various industrial operations.

Many motor skills require eye-hand coordinations. One relatively simple test of eye-hand coordination was illustrated and described in our discussion of aptitude tests. This is the test with the complex coordinator (p. 124) where the subject's reactions are contingent upon settings of red lights, which he attempts to match with green lights.

Other eye-hand coordinations are those in-

volved in tracking behavior. One form of tracking skill known as *compensatory tracking* is exemplified, when we keep our speedometer at (let us say) 45 miles per hour or when a pilot, through his own reactions, keeps his plane on a level course. In another type of tracking skill, known as *pursuit tracking*, a moving target is followed. One example appears in Figure 10.11. Here we have a complicated tracking device which simulates that of a gunner who must keep his sight on a moving target. The coordinations required in order to keep a spot of light on the target are described as follows: "The subject, sitting on a chair, grasps two pistol-grip type handles placed at about chest height. To move the light to the right or left, the handles and the movable structure to which they are attached are turned through a small angle by pushing one handle away while pulling the other toward the body. This is the steering response. To make the light go up, the bottoms of the handles are pushed a short distance away from the subject in a kind of twisting action, and to make it go down, the handles are pulled toward the subject. . . . The speed with which the light moves in any direction depends on how far the handles are turned from the neutral position."<sup>27</sup>

When such tasks are used, the measure of efficiency may be time on the target in seconds. In the present instance, the mean score for a group of teenagers tested at a State Fair began at two seconds per thirty-second trial and, after ten trials, reached more than seven seconds. Further training would no doubt have brought further improvement.

### Verbal skills

We acquire some motor skills partly through memorizing. That is to say, we intend to remember which acts lead to the best results, what we have observed in a skilled performance, and what we have been told by an instructor. Most verbal skills acquired by older children and adults are clearly learned by memorizing. One repeats the material with the intention to recall or recognize it later.

Speaking is a complex motor skill, as well as a symbolic or verbal one. It is acquired partly on the basis of reflex vocalizations which appear during early infancy, but also on the basis of imitation (that is, attempting to copy the vocalizations of others) and trial-and-error activity.

Ability to make combinations of sounds which closely approximate those of adults (namely, "doll" instead of "da," the original vocalization) develops gradually. There is no doubt that maturational factors are involved in this development. Vocalizations produced by adults cannot be copied by the child until auditory-vocal mechanisms, including their cerebral connections, have sufficiently developed. Nevertheless, it is obvious that children learn to speak, just as they learn other manipulative habits. Saying the word "doll," for example, calls for a complex integration of lung, throat, mouth, and tongue movements in properly timed succession. The sound *d* is produced when the tip of the tongue is placed between the slightly open teeth in a certain way, and air is expelled from the lungs. Saying *o* calls for an appropriate manipulation of lungs, vocal cords, tongue, and mouth, as well as of resonance cavities within the throat and mouth. The *l* sound requires manipulation of lungs, vocal cords, tongue, and mouth. Saying "doll" in the adult way calls for a rather definite temporal pat-

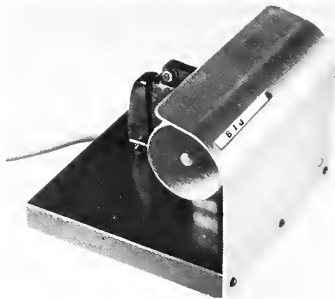
tern of these movements. Such patterns are gradually acquired. Adequately stimulated by his fond parents, and later by formal teachers, the child vocalizes in a trial-and-error fashion, until he achieves the acceptable patterns. Thus he learns to say "doll" instead of "da," "stomach" instead of "tummy," "sugar" instead of "fugar," "light" instead of "yite," "elephant" instead of "fant," and so on.

Verbal skills frequently involved in laboratory studies of learning include recitation of poems or narratives; recitation of lists of words, digits, syllables, or other symbols; and substitution of one kind of verbal material for another, for instance, substituting digits for words or forms. Very little need be said about such materials at this point, for they will be dealt with in more detail in the chapter on remembering, which concerns not the process of memorizing as such, but what is retained after such a process.

The most useful type of verbal material for experimental purposes is the nonsense syllable, or some modification of it. Ebbinghaus (pp. 7-8) pointed out that poems, narratives, words, digits, and similar meaningful material give certain individuals an advantage over others. If one has already learned a poem, for example, his laboratory learning of it does not start from scratch. He has an advantage over somebody who has never before seen or heard the poem. The problem is the same as the one considered in relation to motor skills, where the maze was found to have advantages, for scientific work, not possessed by activities more in line with everyday skills.

Typical nonsense syllables are *fej*, *leb*, and *lir*. Such syllables, of which an almost endless variety may be devised, are usually arranged in lists, either singly or paired. In the first instance the subject merely learns to reproduce them in order, as he would a list of words. This is the simple recall method of learning. In the second instance, however, he learns to repeat the paired syllable when its partner is presented alone. This learning of paired associates is like learning vocabulary lists, where the foreign word is presented and one gives its English equivalent, or vice versa.

A type of apparatus widely used to expose syllables, or other verbal materials, either singly or in pairs, at controlled time intervals,



**10.12 A Memory Drum.** The material to be memorized appears in the slit. One of a series of nonsense syllables rotating on the drum is shown. (Courtesy Ralph Gerbrands, Arlington, Mass.)

is shown in Figure 10.12. An earlier type of memory drum appears in Figure 1.1 (p. 8).

### PROBLEM-SOLVING

The acquisition of all kinds of skills, both motor and verbal, may involve problem-solving. There are, however, many situations in which what we learn is not so much a skill as it is an *understanding* of what must be done. Once we understand, the rest is relatively simple. This is well illustrated by experiments utilizing problem boxes, detour situations, and instruments.

#### Problem boxes

Problem boxes, like mazes, were first used by psychologists to investigate animal learning. The simplest of these allowed the animal to get a reward, or escape (or both) by performing one simple act.

In its essential aspects, operation of a problem box requiring only one movement, such as pushing a rod or pressing a lever is merely operant conditioning. The more complicated problem boxes, of which that in Figure 10.13 is representative, require a combination of acts.

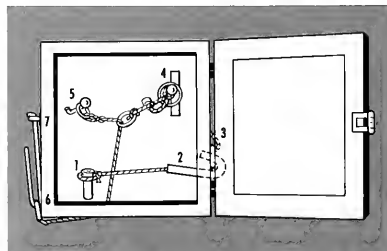
The problem box illustrated is probably too complicated for any animal below man to manipulate appropriately. It must be opened

by inserting the buttonhook into appropriate holes, placing the hook over certain rings, and lifting them off pegs. But the process requires something more than motor dexterity. One must observe the holes; whether the buttonhook will fit into them; whether it will enable the rings to be loosened; and the sequence in which the rings must be lifted. If the problem is to be solved readily, careful observation and a certain degree of understanding are necessary. A chimpanzee would probably not even grasp the nature of the problem. He might, to be sure, make a simple problem out of it by smashing the box. Human idiots fail to grasp the nature of such problems. A normal human subject, however, keeps within limits set by the instructions. He undertakes to open the box with the buttonhook alone, and not to break the glass cover or any of the cords to which the rings are attached.

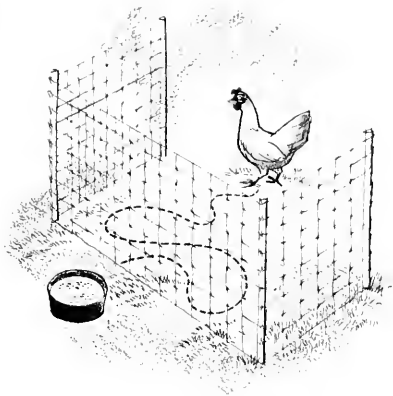
In solving such problems, human subjects sometimes exhibit a more or less random, more or less trial-and-error, approach which is clearly apparent to any onlooker. They pull the string with the buttonhook, turn the box over and around, and pull at the latch. Then, suddenly, they get the idea of inserting the hook into a hole and trying to get at the rings in that way. They try loosening one ring, but soon discover that another must be loosened

### 10.13 Interior View of Healy Puzzle Box.

Seven distinct steps must be followed if the box is to be opened. They are 1. removing ring from post, 2. pulling out staple, 3. removing ring, 4. removing ring from post, 5. removing ring from arm of post, 6. removing ring from hook, and 7. removing hook and opening box. (After W. Healy and G. Fernald.)







**10.14 A Simple Detour Problem.** In this situation the hen does not react with insight. Its behavior is either direct (attempting to get the food through the fence) or random. A chimpanzee, on the other hand, makes the detour almost immediately. He may even climb over the wire. (From Munn, N. L., "The Evolution of Mind," *Scientific American*, 1957, 196, 144.)

first. This sort of behavior continues until the subject gets the box open.

It occasionally happens, on the other hand, that a subject will solve the problem on an observational basis entirely — looking the situation over and making no overt move until satisfied that the box can be opened without error.

I once handed the box in our illustration to a girl in elementary psychology, hoping to demonstrate trial-and-error learning to the class. But she looked at the box a minute or so, then opened it swiftly, without a false move. Upon being asked how she did it, the student replied that she "figured it out." She thought of one move after another, some correct and some incorrect, but made no overt response until she had "figured it out." After this implicit trial-and-error process reached completion, the student put into practice what she had learned observationally. It may have seemed to some that she learned the solution by a sudden "flash" of insight rather than by trial-and-error. Much of the sudden learning, from which insight or understanding is inferred, may be the outcome of some such implicit trial-and-error process.

#### Detour problems

A well-motivated animal will go as directly as possible toward an observable and meaningful goal object, but we may change the situation so that what was a direct means of approach is now blocked, yet with the goal-object still in sight (Figure 10.14). When we do this, the animal can reach the goal only by taking an indirect (roundabout) route. Most animals persist in the direct approach. In higher organisms like monkeys and chimpanzees, however, a direct trial-and-error approach may be replaced, more or less suddenly, by a circumvention of the barrier. It is as if the animal suddenly perceived significant aspects of the situation. We may infer that it learned the problem when it *observed* the inadequacy of the direct, or the adequacy of the indirect approach. This is another instance of what is commonly called insight.

#### Instrumentation

Learning in monkeys, apes, and human children is often studied by confronting them with problems calling for the use of such "tools" as sticks. The animal in his cage, or the



**10.15 Chimpanzee Joining Sticks so that Food may be Reached.** Finding that food is inaccessible with one stick, the chimpanzee picks up the two sticks, fits them together, and pushes the combined sticks toward the food. (From the film, "Monkey into Man," by Huxley and Zuckerman. Courtesy Wolter O. Gutlohn.)

child in his playpen, is shown some desirable object which is out of reach. He can obtain it only by utilizing the nearby instruments. Thus the chimpanzee (Figure 10.15) joins two sticks to reach food which is otherwise inaccessible.

The initial attack on such problems by animals and young children is usually of the overt trial-and-error variety. One stick is used, then the other. One stick may be pushed out with the other until the food is touched. Sometimes the sticks are fitted together, yet without the subject realizing that joined sticks provide a means of solution.

An unusually bright chimpanzee studied by Wolfgang Köhler reacted to the two-stick problem in much the manner described above until, with apparent suddenness, it saw the relation between solution of the problem and the joined sticks.<sup>28</sup> Sudden solution of such a problem, as we saw in the case of puzzle-box and detour learning, is designated *learning by insight*. Apparently, the subject grasps the relation between different relevant aspects of the situation. This is perhaps synonymous with what, in human beings, is known as "getting the idea" or "seeing the point." One psychologist calls it the "Aha experience."

Only limited insight is possible in typical maze situations where but a small portion of the pathway is apparent at one time. This is true also in certain problem situations where significant aspects of the mechanism cannot be perceived. Sudden learning which suggests insight has been observed most often in tool-using situations, because, in these, all aspects of the problem are presented simultaneously. Such situations make it relatively easy for the subject to "put two and two together."

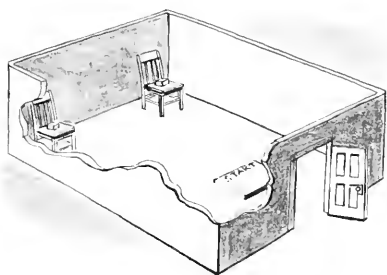
Problem-solving in higher organisms like apes and men is, as we have seen, often observational learning. The subject looks the situation over, perhaps engages in implicit trial-and-error with respect to various aspects of it, then achieves a solution. Through their ability to learn by observing, instead of merely by doing, some of the higher organisms, including human beings, may be aided by observing the performances of others. Thus monkeys and chimpanzees have solved problems, without overt trial-and-error, by watching others solve them. It is said, therefore, that they learn by imitating. Such learning is so important for human beings that it warrants special attention.

#### LEARNING BY IMITATION

Although higher organisms may learn a great deal by observing and attempting to copy the performances of others, they must first *learn to imitate* and, in order for the example to be effective, it must *utilize habits already learned*.

Learning to imitate is illustrated by the following experiment with forty-two first-grade children.

One child (the leader) was told which of two small boxes to open. If he opened it, a piece of candy was found. Another piece in the box was to be left there. The other child (imitator) was rewarded with the second piece of candy if he opened the same box as the leader. He was not rewarded if he went to the other box. In any test, both children stood within the test room at the place marked "Start," (Figure 10.16). On the first test, the children were told: "Here are two boxes, there and there. Here is a piece of candy. You are to find the candy. He gets the first turn. Then you get a turn. If you don't find it the first



### 10.16 The Situation Employed to Teach Children to Imitate. (From Miller, N., and J. Dollard, 29, p. 124.)

time, you will get another turn." The leader always had his turn, then the imitator. The position of the candy varied, of course, from one box to the other in a random order. Twenty per cent of the children imitated on the first trial. Some or all of the 80 per cent who went to the other box may have done so because, seeing the leader get candy out of a box, they reasoned that there would be no more in that box. After an average of three trials, the second child copied the performance of the first child. When the situation was changed, so that the children were confronted by four boxes arranged at the corners of an imaginary square, 75 per cent of the subjects imitated. This demonstrated that they generalized, or transferred to a different situation, the tendency to imitate which they had learned in the first situation. Other children were taught not to imitate. They were rewarded for not doing what the leader did. Their nonimitative tendency transferred 100 per cent to the new situation.<sup>29</sup>

In this experiment it is noteworthy that the children given an opportunity to imitate already had within their response repertoire the basic activities required. They could all walk toward a box, open it, and lift out what was in it. A child who could not already do these things would obviously fail to imitate. This point, quite obvious here, is perhaps not so obvious, although even more important, when skills of far greater complexity, like learning to

dismantle and reassemble a watch or some other complex device, are involved.

Learning of many athletic, industrial and professional skills is today facilitated by moving picture demonstrations of skilled performance. The effectiveness of such demonstrations, as in the illustrations just given, depends upon their use of basic skills already present in the observer.

Regardless of how the subject responds while witnessing an actual or a movie demonstration of a complex skill, the sample performance has at least two decided advantages over a pure trial-and-error approach.

(1) It shows the correct performance, thus enabling the learner to save time and effort which might otherwise be wasted in making incorrect approaches. Suppose, for example, that you were a Hottentot who had never seen or heard of a bicycle — that you had not the least idea what the entire device or its various mechanisms were for, but you were shown a moving picture of a man riding a bicycle. Then, although you would be far from acquiring skill in riding, you would at least know that the device was for transportation, that one sits on a certain part rather than another, and that moving it requires pushing the pedals with the feet. Human beings are often called upon to learn industrial skills just as foreign to their past experience as cycling is to the past experience of the Hottentot. In such instances, seeing a skilled performance saves a great deal of time which would otherwise be spent in trial and error.

(2) Observing skilled performance not only gives general orientation like that described, but it also gives the observer certain insights at the start which, if he ever acquired them during practice, might come only after a long process of trial and error.

### LEVELS OF COMPLEXITY IN HABIT FORMATION

Many complex skills, both motor and verbal, involve an integration of simpler skills. Some involve successively higher stages of integration as learning proceeds. They are, for this reason, referred to as *habit hierarchies*.

Take typing, for example. One first learns to hit the correct keys. These learned responses may be designated *letter habits*. After habits of

striking the correct keys have progressed to the point where the individual is fairly proficient, he finds that he is developing *word habits*. Letters like T, H, and E, instead of eliciting noticeably separate responses, arouse a single response. The individual looks at the word "THE" or thinks it, and the separate responses seem to take care of themselves. After a while, *phrase habits* appear. Common phrases like "Very sincerely yours" are typed without the typist having to pay any attention to either the separate letters or the separate words. The situation in typing may be presented schematically as follows:

Letter habit	<u>T</u> <u>H</u> <u>E</u> <u>B</u> <u>O</u> <u>O</u> <u>K</u> <u>I</u> <u>S</u> <u>D</u> <u>U</u> <u>E</u>
Word habit	<u>THE</u> <u>BOOK</u> <u>IS</u> <u>DUE</u>
Phrase habit	<u>THE BOOK IS DUE</u>

Habit hierarchies are also quite evident whenever messages are to be sent or received in code, as in telegraphy. Indeed psychologists have long been interested in telegraphy and much research has centered upon the most efficient methods of teaching it. There has also been a lively interest in the course of progress in learning to send and receive telegraphic messages.

After complicated skills are practiced for a long while, they tend to run their course automatically. There are many examples of this in everyday life. Think of the concentrated attention that one must give to riding a bicycle for the first time. One is aware of movements made in balancing the vehicle, in guiding it, and in working the pedals. After considerable practice, however, these balancing, steering, and pedaling activities take place automatically — one does not have to think of them. He may daydream or engage in a conversation while riding. Eventually, he rides with as little thought as is involved in walking.

### TRANSFER

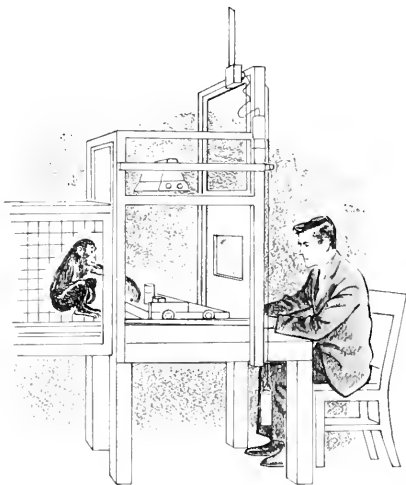
Learning one skill often influences the acquisition of other skills. This influence may be such that the acquisition of one type of performance facilitates learning of another. The influence of earlier learning on later learn-

ing may, on the other hand, be such that acquisition of one skill interferes with acquisition of another. In the first instance we have positive transfer effects, frequently referred to as "transfer of training" or "transfer of learning." In the second instance we have a negative transfer effect, what is otherwise called "negative transfer" or "habit interference."

Higher organisms, including monkeys, chimpanzees, and human beings, are adept at getting the knack of certain situations so that, when they encounter somewhat comparable situations, they know what to do.

A situation used in experiments with monkeys is like that in Figure 10.17. There are

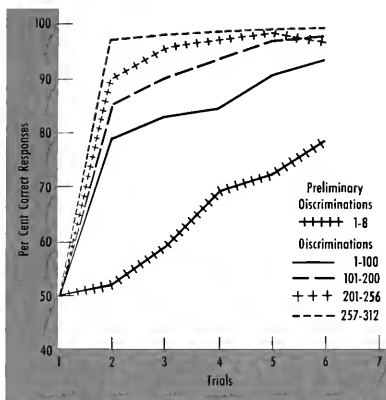
**10.17 Monkey Doing a Learning-to-Learn Test.** The monkey has just lifted the cylinder and is getting a raisin out of the recess below it. Had he lifted the cube, he would have forfeited the reward. A screen would have dropped, preventing response to the cylinder. On the next trial, the cylinder might appear in the same place, or at the left, depending upon a chance order of positioning it. After the stimulus tray is arranged, the screen rises, signaling the time for another response. A one-way vision screen in front of the experimenter prevents the monkey from seeing him and possibly getting a clue as to the position of the reward. (After Horlow.)



two objects and under one of them is a reward, in this case a raisin. The correct object changes position from right to left in accordance with a chance sequence, hence the animal must learn which object is correct. In other words, a position habit will not reward him consistently. Let us suppose that the cylinder is correct. If the subject lifts this he gets his raisin. But if he lifts the cube he gets nothing for that trial. One might think that, after discovering the raisin under the cylinder, the monkey would lift this on the next trial; or that, not finding it under the cube, he would lift the cylinder next time. However, there is the position to be considered. Finding the raisin under the right-hand object, he might associate it with that position, which would be incorrect. Moreover, he might have a preference for one object of the pair. Actually, it takes many trials before the subject "catches on" and consistently lifts the cylinder. The learning curve for the initial discrimination (lowest in Figure 10.18) shows how gradually this is acquired. It suggests that the animal acquires the discrimination on a typical trial-and-error basis.

After the first discrimination habit has been mastered, a new problem is presented. Perhaps the two objects are now a pyramid and a triangle, with the latter hiding the raisin. This problem is learned much more readily than the last one. Then two more objects are presented — say a large cube and a small one, with the small one correct. This is learned even more readily than the preceding problem. New pairs of stimulus objects are used until, finally, the monkey needs only one trial to learn what he is to do. What he does on the first trial gets him the raisin, or it doesn't. On the second trial, however, he reacts by lifting the object that he lifted before (if this was rewarded) or by lifting the other object (if his first trial was unrewarded).

At the beginning of such a series of problems the second trial is correct only about 50 per cent of the time (see lowest curve in Figure 10.18). This percentage rises as training continues so that, after 300 problems have been solved, it reaches the level of 97 per cent or better (see second trial in each curve from bottom up in Figure 10.18). Some monkeys eventually get to the stage where the second trial is always correct.<sup>30</sup>



**10.18 Discrimination Learning Curves on Successive Blocks of Problems.** Note the steady improvement in the lower curve and the sudden mastery indicated in the upper ones. The first trial would, by chance, yield 50 per cent correct responses. The second trials from below up, are worthy of special attention. They begin at the 52 per cent level and are finally at about the 97 per cent level. (From Harlow, H. F. 30, 53.)

Sudden learning like that which occurs in the later stages of such discrimination problems as we have described suggests the presence of insight (p. 289). It is as if the subject "catches on," as if it understands what the experimenter is requiring of it. A variety of organisms in addition to monkeys (rats, cats, chimpanzees, children) have learned such problems.<sup>31</sup>

#### Transfer in verbal learning

Transfer of verbal skills often occurs. When comparable lists of nonsense syllables are learned one after the other, there is a gradual reduction in the trials required to learn successive lists. It is as if the subjects, like those of the discrimination experiments discussed above, are learning how to learn this type of material.<sup>32</sup> Somewhat similar results are obtained with school children memorizing poems,

digits, and other verbal materials. They learn similar materials with greater facility than children without the previous training. Where dissimilar materials are learned, however, transfer is negligible. Thus, children who memorize one kind of material usually do not memorize another kind any better than they would have without the previous training. Where improvement does occur, it is attributable to a carry-over of procedures and attitudes.<sup>33</sup>

### Bases of transfer

Where transfer occurs, either in motor or verbal learning, it comes from (1) *similarity of contents*, (2) *similarity of techniques*, (3) *similarity of principles*, or (4) *a combination of these*.

*Similarity of contents.* Parts of old habits may be "run off" as a response to new situations, perhaps with minor modifications. Thus, after learning items T S Q N A F P L J it is easy to learn T S Q N A F L J R Z because most of the items are learned already. A person familiar with several card games will learn the rules of another readily since many of the new rules are like those he already knows, i.e., a Queen takes a Jack; there are only four Aces in the deck, and so on. After one has learned to drive a car, he soon masters the controls of another. The brake is still under the right foot, a clockwise movement of the wheel steers the car to the right. In school subjects one also finds similarity of contents. Indeed, almost everything we learn in school is conveyed to us through words and other symbols learned earlier. Without this "common content," how could we hope to learn history, biology, physics, and other subjects? There is transfer from mathematical skills to mechanical engineering skills, because both involve the same symbols and symbolic relations. Transfer from one language to another occurs if the symbols and grammatical construction are alike. There is very high transfer from Spanish to Portuguese because of this similarity; and there is a certain amount of transfer from English to French because many words are similar.

*Techniques.* There are courses in how to study which aim to teach the student how to organize his learning so as to make him maximally efficient. Any transfer that comes

from such courses is a transfer of study techniques.

Transfer in terms of techniques also occurs if, having learned the scientific approach to problems in one subject, the student applies scientific procedures to problems in other fields. Likewise, if the student takes a course in formal logic and thereafter thinks more logically, or tests his thinking in terms of logic, the procedures of formal logic have been transferred. Occasionally, a student who has learned in mathematics to formulate a problem by letting  $x$  equal this,  $y$  that, and so on, applies the same type of formulation to comparable problems in everyday life.

A word of caution is, however, in order. Having taken a course in how to study, in scientific method, in logic, in mathematics, or any other subject, does not guarantee that transfer will occur. The teacher with his eye on transfer will do well to give practice exercises in which transfer is called for. That is, he will teach how to transfer the methods to practical situations. Transfer, even though possible, does not take place automatically.

*Principles.* Transfer of principles is not always clearly different from transfer of techniques, because the use of a technique may involve the application of principles.

An experiment which clearly involves transfer of principles is illustrated by the following: Children learned a problem in which one of several doors containing figures, and above which figures appeared, was to be opened in order to get a hidden toy. The principle which the children were to learn by their trial-and-error activities was this: "The correct door is always the one whose figure matches the one above it"; or, "none of the wrong doors have figures which match those above." After having learned this problem with figures, many children learned, without any further training, new problems in which colors were used. Having learned the principle with figures, they applied it to the color problem. Transfer was 100 per cent.<sup>34</sup>

A study of puzzle-solving in human adults showed that, when subjects were taught the principle involved in solution of one problem, they solved, without any error, new puzzles which involved the same principle. Those who did not learn the principles involved failed to show much transfer.<sup>35</sup>

In one of the best-known experiments on transfer of principles, a group of boys was given instruction in principles of refraction, while another comparable group received no such instruction. Both groups were then called upon to hit an underwater target with darts. This they accomplished with approximately equal success. But when the target was shifted to a new position, the boys with a knowledge of the principles of refraction made a much more rapid readjustment than did those with no knowledge of these principles. The investigator came to the conclusion that generalization, or application of principles to new situations involving the same principles, had occurred.<sup>36</sup>

### Formal discipline

Studies of transfer have failed to support the contention, once quite prevalent, that training in certain subjects, such as Latin and mathematics, serves to strengthen particular psychological functions. This doctrine, known as that of "formal discipline," has often been used to justify inclusion in the curriculum of studies which, although having no apparent practical value for certain students, are said to be useful in "improving memory," in "improving judgment," in "strengthening the scientific intellect," or in "giving elasticity to mental functions." The evidence from experimental investigations shows that transfer, where it occurs, is due to similarity of contents, of techniques, or of principles, not to development of particular psychological faculties or functions.<sup>37</sup>

When we say that a subject like Latin does not, any more than some other subject, increase one's intellectual capacities, we are not saying that studying it is a waste of time. It is exacting, and some people like to master exacting subjects, even when they see no practical outcomes. But it has also been maintained, apparently with justification, that the study of Latin improves one's English vocabulary and makes the many English words with Latin derivatives much more meaningful than they would otherwise be. Much of the Latin idiom is lost in translation, so that a student who wishes to feel and think with the Romans can do it better by reading Latin than by reading translations.

The same is also true of Greek, as well as modern languages. But we must again call attention to the fact that transfer, although possible, does not necessarily occur. Students who were taught geometry in the traditional manner improved slightly in reasoning ability in relation to nongeometrical problems whereas a group that was taught geometry in such a way as to emphasize critical thinking showed marked transfer to other reasoning situations.<sup>38</sup> Similarly, the study of Latin does not necessarily improve the student's English vocabulary. It does so, however, when special attention is given to the Latin derivation of English words and how to recognize and interpret Latin roots when they are present.<sup>39</sup>

### Habit interference

Many errors made in the early stages of learning are responses transferred, although inappropriately, from previous habits. Sometimes we experience great difficulty in eliminating these inappropriate responses. Since "carry-over" from earlier training is usually a mixture of useful and useless, or interfering responses, we can see that whether transfer is positive or negative depends upon whether one's learning as a whole is aided or hindered by previous training.

When we come to thinking and reasoning (Chapter 12) we shall see that many of the errors, or false tries at solution, are carried over from what we have learned in other problem situations, but are inappropriate to meet the new situation. They send our thinking in the wrong "direction" and thus interfere with solution.

We see habit interference in everyday life. The person who has learned to drive a car with a left-hand drive has unusual difficulty in learning to drive one with a right-hand drive. Anybody who has habitually guided a sled with his feet experiences a certain amount of interference when he learns to guide a plane. Pushing the rudder bar with the right foot sends a sled to the left, but it sends a plane to the right. Sometimes, too, the pilot, when wishing to turn, will try to use the wheel rather than the rudder bar. Some flyers have found themselves in difficulty because their training plane diff-

ferred in certain respects from the plane they were finally called upon to fly. Thus

a pilot, in attempting to correct for under-shooting a field, pulled back on the throttle and pushed the stick forward, resulting in a nose dive into the ground. This incorrect pattern of adjustment was due to the fact that the pilot was flying a plane in which the controls were placed differently from those in the plane in which he was trained. He was used to advancing the throttle with his right hand and pulling back the stick with his left hand; and the "left-hand-back, right-hand-forward" habit pattern transferred itself automatically, to the pilot's astonishment and resulting distress.<sup>40</sup>

Habit interference in verbal activities also occurs at times. After the end of the year, you may continue for some time to write the previous year on your checks, and you may continue to write May after June has arrived. Likewise, after your telephone number, or that of a friend, has been changed, you may continue for a time to use the former number. Students are sometimes "tripped up" by the construction or sounds of new words so that negative transfer occurs.<sup>41</sup> Here is an example. When asked to define "recapitulation," some said that it meant "recovery" (from recapture), some "refinancing" (from recapitalizing) and some "renewed life" (from recuperation).

Negative transfer, like positive, occurs on the basis of similar content, techniques, or principles, but it involves interference rather than facilitation. The contents, techniques, or principles which make for negative transfer are opposed to those required by the new situation.

#### FOUNDATIONS OF LEARNING

From what has been said about conditioned responses, motor and verbal skills, problem-solving, and various aspects of transfer, both positive and negative, one might wonder how such a wide variety of acquisitions can be subsumed under a single term, such as *learning*. Despite their apparent diversity, however, all of these have at least two features in common.

In the first place, all learned responses involve *modifications of the organism*. These are

usually conducive to improved adaptation. The only exception is when "bad habits" are learned. Acquiring skills and information is obviously adaptive. Learning *not* to do something injurious or painful is also adaptive.

In the second place, the modifications which occur when we learn are dependent upon *what happens to us as individuals*. They are produced by the effects upon us of changes in stimulation, by activity, by practice, by special training, by observation, or by a combination of these. It is important to recognize these foundations of learning for the reason that unlearned modifications of behavior also occur. This is especially so during the early months and years of human life. These modifications have already been discussed as changes in the organism resulting from natural growth processes, or maturation.

Our discussions of reinforcement, both primary and secondary, make it apparent that motivation plays an important role in learning. For this reason we now examine some representative studies on motivation and learning.

#### THE ROLE OF MOTIVATION

In research on learning it is almost axiomatic that adequate motivation must be provided. The hungry animal must receive food; the thirsty one, water; or the punished or confined animal must escape. Such reinforcement is obviously necessary where learning of skills is concerned. It is not so obviously an aspect of conditioning, but even here, as we pointed out earlier, reinforcement of some kind seems necessary. Instrumental conditioning provides reinforcement in that the organism's response brings food or escape. Classical conditioning may also involve reinforcement in this sense. That is to say, the conditioned response may relieve tension, or expectation.

What is emphasized in the examples which follow is the relative effectiveness of different kinds and degrees of reinforcement.

#### Rewards in animal learning

Learning of hungry rats which found food at the end of the maze was compared, in one investigation, with the learning of rats which were hungry and found no food, and with the learning of rats which were not hungry and



found food. As illustrated in Fig. 10.19 the hungry rewarded group showed normal progress toward mastery of the maze habit, while the other groups exhibited little progress. The slight learning by hungry nonrewarded and less-hungry rewarded rats may be attributed to the incentive value of escape from the maze. Time scores for these groups actually increased during the course of the experiment, while those for the hungry rewarded group decreased in the normal manner.

When hungry rats run the maze without finding a food reward, as in the case of the hungry nonrewarded animals above, and a food reward is later introduced, there is a sudden drop in the time and error curves. Maze performance in the absence of food suggests that little or nothing is being learned. But when food is introduced at the tenth trial, performance soon approximates that of a group rewarded continually over a long period.<sup>42</sup> Such sudden improvement, as we said earlier (p. 283), suggests that the animals had acquired *information about the maze* which they did not utilize until, after the tenth day, it became advantageous for them to do so. This so-called *latent learning* has led some psychologists to make a distinction between learning and performance and also to claim that learning can occur without reinforcement.<sup>43</sup>

That the rats acquired their information without reinforcement from food is obvious, since there was no food. But what about other

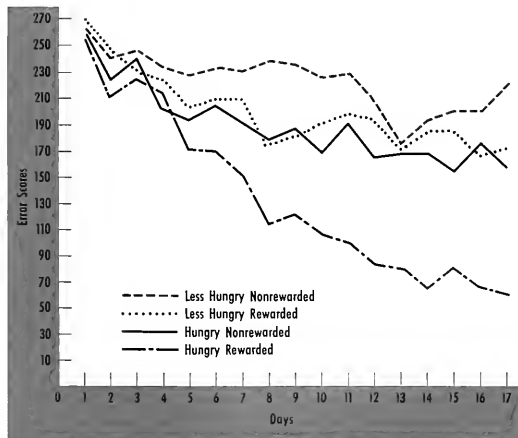
reinforcing conditions? Several may be inherent in the maze situation. If the animal has an exploratory drive (or what in a child would be called curiosity) the satisfaction of this drive would itself provide reinforcement. Being removed from the maze, as well as returning to the home cage, might also provide reinforcement. Any hindrance to the rat's ongoing activity, such as running into a blind alley and having to turn to get out of it, might provide negative reinforcement. There is additional evidence of latent learning. This comes from other experiments in which information was apparently acquired, yet not utilized in overt response until relevant incentives were introduced.<sup>44</sup> But there is no satisfactory evidence that such learning occurred without reinforcement of some kind.

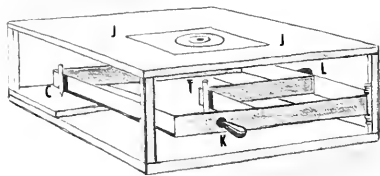
Withdrawal or delay of reward,<sup>45</sup> or change to a less preferred reward, after performance has reached a high level of efficiency, all lead to less efficient maze running.<sup>46</sup>

In human learning the reinforcement comes more often from money, praise, or recognition than from food.

Numerous experiments on learning in rats and human subjects have, compared the effect of punishment and reward, the punishment usually being a mild electric shock. In most of these studies, involving a variety of learning situations, shock for errors has been more effective, in combination with reward, than reward alone.<sup>47</sup>

**10.19 The Effect of a Food Reward on Maze Learning in Rats.** Observe that the rapidity of learning, and the level of achievement, varied with motivation and reward. (From Tolman, E. C. and C. H. Hanzik, 42, 246.)





## 10.20 Two-Hand Coordination Apparatus.

The subject was instructed to move handles **K** and **L** in such a manner as to throw a spot of light from the torch **T** upon the bull's-eye of the target, **J.J.** Too small a movement of **K** caused the spot to move too far to the left. The performance was registered on a sheet of paper at **C.** A score of 10 was given for a bull's eye, 9 for the next ring-out, and so on. The outermost ring scored 1 and a miss scored 0. The subject was required to move both hands just once at each trial. Therefore, he was not allowed to explore until he located the target. (From Elwell, J. L., and G. C. Grindley, 48, 41.)

### Knowledge of results

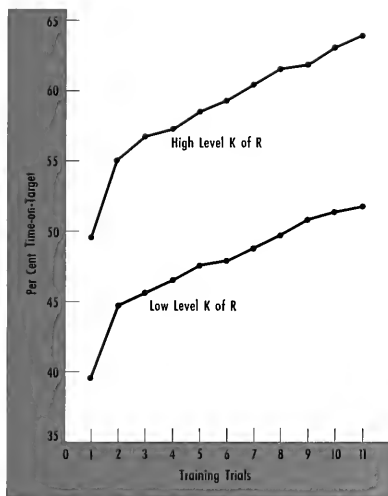
Motor skills are not generally acquired unless the subject has some knowledge of results, some informational feedback. This is neatly illustrated by an experiment in which the apparatus of Figure 10.20 was used. By proper manipulation of both handles at once, the subject could move the spot of light onto the bull's-eye. He was given a score based upon how close he came to the bull's-eye. After preliminary practice, two groups were trained, one with the light off so that no knowledge of accuracy would be possible, and the other with the light on so that accuracy in hitting the target would be known. Subjects working without knowledge of results failed to show any improvement. They became exceedingly "bored" with the whole procedure. On the other hand, those who knew the accuracy with which they hit the target, improved rapidly as practice continued. Withdrawing knowledge of results was followed by a deteriorating performance.<sup>48</sup> Nu-

merous experiments on a wide variety of skills add support to these findings.<sup>49</sup> In some experiments it has been possible to vary such factors as the amount of information given and the interval between the subject's reaction and the informational feedback.

Subjects in one experiment tried to keep a fluctuating needle on the zero mark for as long a period as possible.<sup>50</sup> This is of course a compensatory tracking problem. Subjects could see when the needle deviated very much from the zero point, hence there was some visual knowledge of results. However, a visual signaling system was arranged so that small increments of cumulative time on the target could also be indicated. In addition, an auditory signaling device was arranged so that a subject wearing earphones could hear clicks which indicated his level of success in staying on the target. One group (high-level knowledge of achievement) received this additional visual and auditory feedback throughout each ninety-second trial. Another group (low-level knowledge of achievement) had no informational feedback during each trial except that naturally present in watching the needle. At the end of each trial, however, they were told their score for that trial. Learning curves for these groups are shown in Figure 10.21. It is quite evident that the greater information resulted in more efficient performance.

Another experiment<sup>51</sup> required subjects to draw lines of a particular length while blindfolded. Whether a line was too short, correct, or too long could not be known to the subject unless he were told how he had performed. A control group was told nothing. The information, "short," "long," or "correct" was given to another group as soon as the response had been completed. With other groups, this information was delayed for 10, 20, or 30 seconds. The mean number of correct responses in 50 trials was: no knowledge of results, 4.25; immediate knowledge of results, 27.38; 10-second delay, 21.88; 20-second delay, 15.00; and 30-second delay, 14.00. All differences were statistically significant except that between the 20-second and 30-second delay groups. It is clear that learning under the condition of immediate reinforcement was superior to that under the other conditions.

The practical application of such findings is



**10.21 Knowledge of Results in Compensatory Tracking.** The low knowledge-of-result group had no more visual information feedback than could be gained by watching the needle. A report of their time-on-target score was given after each trial. The other group had additional auditory and visual feedback during each trial. This figure does not include data on transfer which were also in favor of the group with the greater knowledge of results. (From Smade, A. F., 50, 300.)

to give the learner a knowledge of results as soon as possible after his response. This has been of demonstrable advantage not only in laboratory experiments like the above, but also in teaching chemistry,<sup>52</sup> and in teaching soldiers how to improve their marksmanship.<sup>53</sup> In our discussion of teaching machines we referred to their use of the principle that learners should know the results as soon as possible and have a chance to correct erroneous responses.

The improved performance associated with knowledge of results may be attributed to at least three things: (1) repetition of responses known to be successful, (2) at-

tempts to correct responses known to be inadequate, and (3) enhanced motivation, in the sense that subjects working with knowledge of results find the task more interesting and try to improve their performance.

#### THE RELATIVE ECONOMY OF DIFFERENT LEARNING PROCEDURES

Assuming that the subject is well motivated, what are the best procedures to be followed in developing proficiency? Is it better, for example, to concentrate practice periods, or to distribute them with a shorter or longer interval between? Within a given practice period, is it better to give just one trial, or to give a number of trials? What is the most economical interval to introduce between practice periods—one hour, six hours, or a day? In learning verbal or motor skills, is it better to go over the material again and again, without a recitation or rehearsal, or is it better to introduce recitation or rehearsal periods at intervals during the original learning? If so, what proportion of the learning time should be given to reading, and what proportion to recitation?

#### Distribution of effort

Here we actually have two problems: (1) what is the optimal amount of work per practice period—i.e., between rest periods? One might study for 15 minutes, 30 minutes, or 60 minutes before taking a rest. (2) Given a certain work unit, what duration of rest is most effective? If one is to study for 30 minutes at a time, for example, should he rest 5 minutes, 10 minutes, 15 minutes, or longer between each study period?

Variations in the unit amount of work and in the length of the rest period, singly and together, both influence the progress of learning. However, the optimal work unit or rest interval, or the optimal combination of these, varies a great deal for different tasks, for different subjects, and different degrees of motivation. The following references to three laboratory investigations suggest the design of experiments utilizing (1) different amounts of work, (2) different durations of rest, and (3) different combinations of work and rest.

*Amount of work per period with the rest*

period constant. Three comparable groups of college students were given six practice periods of, respectively, one, two, and four minutes on a pursuit tracking test. The rest interval in each case was three minutes. Comparisons were based on the per cent of time that the subject was on the target. In all six trials the percentages for the two-minute group were higher than those for the other groups. This was true despite the fact that the two-minute group had a total of only twelve minutes of practice as compared with twenty-four minutes for the four-minute group.<sup>54</sup>

*Constant amount of work with variation in the duration of rest.* In a study on the influence of different durations of rest, each work unit (trial) comprised 20 exposures of a list of 18 nonsense syllables. The group with massed learning had continuous practice for 22 trials, but other groups were given a rest of, respectively, 8, 3½, 2 and 1¼ minutes between trials. Figure 10.22 represents the learning of these

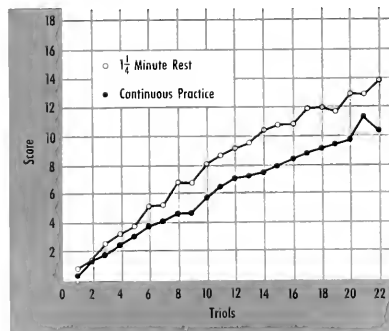
18 nonsense syllables by the group with no rest and the group with a 1¼-minute rest. The longer rest periods were all more economical than zero rest, but not more so than this shortest rest period.<sup>55</sup>

*Work and rest periods independently varied in learning the same task.* This type of experiment is illustrated by a study which required students to pick up, turn over, and replace small cylindrical blocks in four rows of 15 holes each (see Figure 5.6, p. 123). Each subject's score was the number of blocks that he turned over. The design of the experiment is shown in Table 10.1. Observe that, with work constant at 10 seconds, rest periods of 10 and 30 seconds were used. With work constant at 30 seconds, 10- and 30-second rest periods were again used. This experimental design enabled the experimenters to discover

Table 10.1 Design of the Experiment  
(From Kimble and Bilodeau)

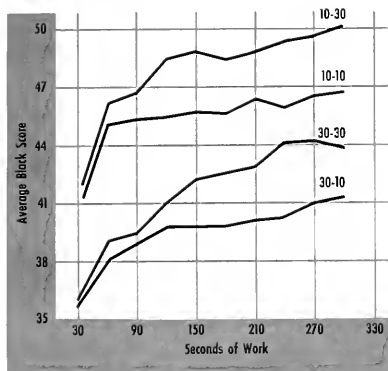
Group	Work period	Rest period	Number of subjects
1	10 sec.	10 sec.	24
2	10 sec.	30 sec.	24
3	30 sec.	10 sec.	24
4	30 sec.	30 sec.	24

**10.22 Learning as Influenced by the Rest Interval.** Observe that the group with continuous practice did not, after the second trial, reach the performance level of the group given 1¼ minute rest intervals. The score was the number of syllables correctly anticipated (recalled without prompting). With the anticipation method, one syllable is given, and the subject tries to recall the next. If, within a fixed period, he fails to do so, the syllable is given, and he attempts to recall (anticipate) the next, and so on until the last syllable is reached. (From Wright, S. T. H., and D. W. Taylor, (55, 529.)



which is a more important determiner of efficiency in performing the task, the amount of work or the duration of rest. It also indicated which combination of work and rest brings the most efficient learning. The results are summarized in Figure 10.23. Note that the 10-second work period with either a 10- or a 30-second rest, yields the higher average scores. We can thus say that a 10-second work period, for this task, is more economical than the 30-second work period. Also, the 10-second work period is superior with a rest period of either length. Thus we can also say that the amount of work is a more significant variable than the rest period. But the efficiency of performance *does* also vary with the rest period. Observe that with either work unit, the 30-second rest is more economical than the 10-second rest. The most economical combination of work and rest is a 10-second work period and a 30-second rest.<sup>56</sup>

The most effective work unit for any task,



**10.23 Learning as Influenced by the Amount of Work and the Duration of Rest Periods.** 10-30 means a 10-second work period with a 30-second rest between periods. This combination gave the highest scores (average number of blocks turned over and replaced). Note that both 10-second work groups reached a higher level of performance than either of the 30-second work groups. With both work units, the 30-second rest period yielded the higher scores. (From Kimble, G. A., and E. A. Bilodeau, 56, p. 153.)

as well as the most effective interval of rest, must, as we have already said, be determined for the particular task and subjects concerned. Indeed, it has been shown that here, as in experiments on details of intentional versus incidental learning, many variables influence the effectiveness of a particular procedure.<sup>57</sup>

Sometimes a practical situation arises which, despite its poor economy in other respects, may make massed practice more desirable than distributed practice. Suppose, for example, that skilled workers could be turned out with fewer lessons if their lessons were shortened, or came after a longer interval, but that you needed skilled workers in a hurry. Let us say that a certain skill is acquired in 50 standard lessons when lessons are given 5 times daily, and in only 30 when they are given one day apart. Distributed learning saves 20 lessons. With massed practice, however, a worker acquires the skill in 10 days; with distributed learning

he acquires it in 30 days. Economy in time to get skilled workers, therefore, might dictate massed learning even though workers would need 20 trials in addition to those required if learning were distributed over a longer period.

There is another practical consideration which might make a certain degree of massed learning better than distributed learning. Some individuals take a long time to "get down to business" in studying or other kinds of learning. These would waste a large proportion of each interval before accomplishing anything, hence, might accomplish more if they worked a longer period at a time.

### Why distributed learning is economical

There are various reasons why distributed learning is generally more economical than massed learning. These reasons will be considered with respect to (1) the work unit, and (2) the rest period.

*The length of the work unit.* If this is prolonged, fatigue may set in, thus offsetting the effectiveness of one's efforts. Everyone has experienced the "lost motion" of trying to study, or to accomplish anything else, while fatigued. A short work unit, moreover, usually produces better motivation than a long one. Extra effort is induced, as in a short sprint. But a large work unit induces us to save ourselves for the "long pull" ahead.

*The rest period.* A rest period, like a short work unit, reduces fatigue and leads to improved motivation, but it has additional advantages. Once we stop work there is apparently a perseveration of neural processes aroused by our activities.<sup>58</sup> Such perseveration perhaps underlies the "running of a tune through the head." According to one theory, perseveration "consolidates" what has been learned. A rest period is thus assumed to be advantageous because intense external stimulation ceases and allows internal consolidation to occur.<sup>59</sup>

<sup>58</sup> This does not mean that the individual is rehearsing the material during the rest period. In fact it has been shown that rest periods are as advantageous in animal as in human learning. It is not likely that a rat, for example, would be implicitly rehearsing what it has been learning.<sup>58</sup>

There is evidence supporting the view that organisms resist (are refractory to) early repetition of an act. This "reactive inhibition," as it is often called, may be a further reason for the relative ineffectiveness of massed learning. Rest periods obviously reduce the necessity for such repetition.<sup>60</sup>

One other factor may be of even greater importance than those already mentioned as favoring rest periods in learning. This is the tendency for incorrect associations (errors) to be forgotten faster than correct ones. We would expect such differential forgetting, the reason being that erroneous responses receive no positive reinforcement. But how does this bear upon the effectiveness of rest periods? The answer is that without a rest, forgetting cannot so readily occur. With an interval between trials, forgetting occurs, with the incorrect associations being weakened much faster than the correct ones. If the incorrect associations weaken faster than the correct, there is of course a relative advantage to the latter when practice is resumed after the interval.<sup>61</sup>

We see, then, that fatigue, poor motivation, restricted perseveration, resistance to early repetition of an act, and hindrance to differential forgetting of correct and erroneous responses may all contribute to the lessened efficiency of massed as compared with distributed learning.

### **Recitation**

The value of recitation versus mere reading has been investigated for memorizing a variety of verbal materials. The best-known study is that in which large groups of children from several grades memorized nonsense syllables.<sup>62</sup>

Some children put 100 per cent of their time into reading the material. A comparable group put 80 per cent of its time into reading, and 20 per cent into reciting what it had read. Another group, comparable with the others, put 60 per cent of its time into reading and 40 per cent into reciting, and so on, down to the group which put only 20 per cent of the time into reading and 80 per cent into reciting. The outcome was quite clear: the larger the percentage of recitation, up to the limit indicated, the greater the efficiency of learning. In this instance the largest amount of recitation was 80 per cent.

In a more recent investigation with fifth- and sixth-grade children memorizing nonsense syllables, arithmetical facts, a difficult English vocabulary, and spelling, almost all the various distributions of reading and recitation used were better than reading without any recitation. The results of both studies make it clear that recitation contributes to efficiency in memorizing.<sup>63</sup>

Why recitation should be more efficient than mere reading is fairly clear. In the first place, reading with the knowledge that one must soon recite what he is reading is conducive to good motivation — to what some have called "the will to learn." We have seen that intentional learning is often more efficient than incidental learning. In the second place, a recitation tells us how well we are progressing. It gives a better knowledge of results than could occur from passive reading. Every time we reproduce something read there is a reward element introduced, and every time we fail to reproduce an item there is an effect somewhat comparable with punishment for incorrect responses. In the third place, one must eventually recite the material — so the person who recites is practicing the sort of reproduction he aims to achieve.

The efficiency of learning is also dependent upon basic conditions which we have already discussed in our considerations of conditioning and the acquisition of skills. These are summarized in the following discussion.

### **SOME BASIC CONDITIONS FOR LEARNING**

Just about all we can do and everything we know is learned. This diversity of acquisitions suggests either that there are different learning processes or that there is a single process with diverse manifestations.

Some theorists distinguish different kinds of learning, like learning responses and acquiring information.<sup>64</sup> One of them says that there are really six different kinds of learning, or at least the learning of six different kinds of relationship, including the two just mentioned.<sup>65</sup> On the other hand there are those who, like Pavlov, postulate but one learning process.<sup>66</sup> The reader may recall Pavlov's statement (p. 271) that all learning is response conditioning.

Pavlov's idea stimulated theoretical discussion, as well as correlated research, all of which led to various modifications of his original theory. Of the various theories which got their impetus from this idea, and which still postulate a single learning process, that of the late Clark Hull of Yale University is probably the best known and, with some modification, most widely accepted.<sup>67</sup> Hull developed an elaborate and logically well-organized theory to deal in a most comprehensive way with learning and behavior. What Hull's theory postulates, basically, is that learning involves the acquisition of stimulus-response associations. Hull felt that, when we have discovered how learned responses come to be associated with the stimuli which arouse them, we shall perhaps be able to extend this knowledge to embrace all learning of whatever complexity. Knowledge, for example, might involve complicated acquired responses of brain mechanisms to relevant stimuli, internal or external.

It remains to be seen whether all learning, from acquiring conditioned responses to understanding the calculus, can be reduced to a common basis. If there is basically only one kind of learning, then we may look for one set of principles capable of explaining every acquisition. On the other hand, if there are basically dissimilar learning processes, we shall need a somewhat different set of principles to explain each.

Without attempting to prejudice the issue of whether there is basically only one learning process, or two, or even more, we can at least examine certain principles which appear to play an important role in conditioning, acquisition of skills, and problem-solving. These principles have already been mentioned, or implied, and what we shall do now is to bring them into sharper focus, elaborate on some of them, and show certain interrelations.

### Contiguity

Our discussion of conditioned responses disclosed that, if a previously neutral stimulus is to arouse a response, the conditioned and unconditioned stimuli (and the response) must occur fairly close together. While the conditioned stimulus need not be presented simultaneously with the unconditioned stimulus, it must appear soon before or soon after.<sup>68</sup>

The most effective arrangement, as we saw, is to have the conditioned stimulus precede the unconditioned by an interval of about one-half second. This proximity of the two stimuli, or of the conditioned stimulus and the conditioned response, is what we mean by contiguity. There is contiguity in time, and also in space, for the events to be related are presented in approximately the same place as well as the same time.

Contiguity is also important in all other learning. In learning a maze, the stimuli which eventually serve as cues, or sign posts, are contiguous in time and space with the consequences of responding to them in one way or another.<sup>69</sup> A turn in one direction leads to food; in the other to a blind alley entrance, and perhaps punishment, or at least delay and wasted effort. In puzzle-box learning, one response is soon followed by reward or, if it is the incorrect one, by continued frustration. In verbal learning, also, the things to be associated must occur close together. Whether we are recalling a list of verbs, or reciting a poem or narrative, each response brings the stimuli for the response contiguous with it in the original learning situation. Thus "Fourscore and . . ." is followed by "seven"; that by "years" . . . and so on, as we recite the Gettysburg Address.

All theories of learning imply, or take for granted, the presence of contiguity. Some theorists believe that contiguity is sufficient in itself to produce learned associations,<sup>70</sup> or, as in the case of so-called latent learning (p. 297), to inform the organism of "what leads to what."<sup>71</sup>

In conditioned-response experiments, however, an organism learns to associate only those things which are *relevant to motivating conditions*. A bell, for example, may cause the dog to prick up his ears, although it does not make him salivate. Food produces salivation. Upon continued association of bell (and ear-pricking) with food (and salivation) what we get finally is an association between bell and salivation, not between food and ear-pricking.

As another example of the insufficiency of contiguity *per se*, one might take something to be discussed more fully in the next chapter, viz., the association of names with faces. You see a face and hear the person's name, but this alone is not always sufficient to enable you

to recall the name when seeing the face later. To contiguity of name and face there must be added some motivational factor, like your intention to associate the name with the face.

### Motivation and reinforcement

The importance of motivation for *efficient* learning has already been considered. The question now before us is whether motivation, like contiguity, is an essential aspect of learning. Some theorists, including Hull, believe that it is. There is much experimental evidence in support of this conclusion. Latent learning is an apparent exception. But we have seen (p. 297) that even this is conceivably motivated. Another possible exception is classical conditioning, where the obvious consequences are the same regardless of what the organism does. In this case there is always the possibility that making the response relieves tension, or terminates an attitude of expectancy.

The motivated organism — the one with needs, tensions, or expectations — usually does something about the situation in which it finds itself. It explores, or it manipulates this or that part of its surroundings. Eventually it may do something which reduces its tension, thus reinforcing the response. Here we have the core of Hull's learning theory.

Primary reinforcement is conceived of by Hull, not as need-reduction in itself, but as a *strengthening of the stimulus-response connection* which accompanies need-reduction. We also referred earlier (pp. 280–281) to *secondary reinforcement*. Among the examples mentioned were token-rewards, money, and praise. In secondary reinforcement, according to Hull, "the reinforcing agent is a situation or event involving a stimulus aggregate or compound which has been closely associated with . . . need reduction," and secondary reinforcement is the resultant "strengthening of the receptor-effector connections."<sup>72</sup>

Primary reinforcement, in the sense of dependence of connections upon biological need-reduction, is most evident in the learning of hungry animals given a food reward, or of thirsty ones given water. One may recall from our discussion of needs and drives, however, that certain conditions may have a reinforcing effect without reducing a physiological need (or

drive). There may be reinforcement from food (or water) in the mouth (or stomach) almost immediately, whereas time would be necessary to re-establish bodily equilibrium. Another example is the reinforcing effect of saccharin, which has no food value. In addition to such forms of reinforcement one will call to mind the so-called "nonhomeostatic" exploratory and manipulatory drives (pp. 152–154).

While primary reinforcement may involve drive-reduction in the sense that tensions, expectancies, or the like are relieved, it does not necessarily involve a homeostatic effect, at least in the physiological sense. Thus, to the animal with a "sweet tooth," saccharin may be reinforcing even though it does nothing to change the carbohydrate level of the blood.<sup>73</sup> And, looking out at the world around it, or having a chance to manipulate some hooks and bolts, may be reinforcing to a monkey even though doing these things is unrelated to a physiological deficit.<sup>74</sup> In each instance, of course, some motive (to taste sweet things, to see what is going on, to explore or manipulate) is being satisfied.

Because of such difficulties with the physiological concept of need reduction, Hull modified his position by saying that reinforcement may come from "*drive* reduction," which has no necessary physiological connotation.<sup>75</sup>

Hull, as we saw above, also credited secondary drives with reinforcing potency. It is clear that such drives do develop and subsequently play an important role in learning. In our society, for instance, the individual soon acquires such secondary motives as the desire for recognition, for verbal affection, and for material things, including money. In older children and adults, the reinforcers of such secondary drives — reinforcers like awards for achievement, kind words, and money — are normally of greater significance than such primary reinforcers as food and, from the negative standpoint, physical punishment.

### Repetition

Learning sometimes occurs in a single contact with a situation.<sup>76</sup> This is often true when the stimulation involved is intense, or vivid, as when the child puts its hand on a hot stove, and never does so again. Under emotional circumstances we sometimes learn an association



in an instant, even the name which goes with a certain face. We may learn a performance, moreover, by imitating someone, and with only one demonstration. This may be true if we already have the component skills and need only integrate them in the demonstrated fashion. In most learning, on the other hand, a certain amount of repetition is necessary. This is sometimes referred to as the principle of *exercise*, or of *frequency*. The basic idea is that, in order to strengthen a stimulus-response association, one must repeatedly present the learning situation. Several investigations have, however, shown that mere repetition is ineffective.<sup>17</sup> We saw this in attempts to develop skills without knowledge of results.

Except in rare instances, if learning is to occur, one must repeat in *close contiguity*, the *stimulating circumstances*, the *responses elicited* by these, and the *associated reinforcement*, whether primary or secondary. When this combination occurs repeatedly, the usual result is greater frequency, magnitude, or fixation of the reinforced responses. Responses not followed by positive reinforcement or those negatively reinforced tend to drop out, to be extinguished. This principle holds even though, as some studies have shown, reinforcement may be intermittent (p. 279).

The role of repeated reinforcement is most obvious when an organism acquires conditioned responses of the instrumental type and when sensorimotor and verbal habits are learned. It is also evident in problem situations. An apparent exception occurs in sudden learning which suggests the gaining of insight. But,

as we have already suggested (p. 289) this may involve implicit trial and error. In the higher types of problem-solving, as when human subjects learn a principle, it is difficult to assess the role of repeated reinforcement. Motivation is important and so, presumably, is reinforcement, but the latter is not as obvious as in simpler forms of learning. Reinforcement could at times be implicit; as when satisfaction comes with one's realization that progress is being made; or his dissatisfaction upon realizing that he is failing to approach the solution.

Acquiring information, as from books and teachers, or incidentally during the course of everyday life, is even more difficult to envisage in terms which seem to account for acquisition of conditioned responses, and the simpler sensorimotor and verbal skills. Hull, whose work was primarily with conditioning and maze learning in white rats, was fully cognizant of this. He believed, as we have said, that one should begin with simple acquisitions in a relatively simple organism and that the principles there derived might provide the foundation for a theory which would embrace even the most complex learning.

Much of the current research on learning is centered on the theoretical issues that we have discussed. The results of current experimental studies of these problems are bound to have important implications not only for learning theory but also for other aspects of psychology, such as perception, motivation, individual differences, personality, and the field of applied psychology, including education.

## Summary

Conditioned responses are simple habits. Many were initially reflexes elicited by *unconditioned* stimuli. An example is salivation elicited by food in the mouth. Conditioning has occurred whenever some previously ineffective stimulus arouses such a response — as when ringing a bell produces salivation. The bell is in this case a *conditioned* stimulus and salivation a *conditioned* response. In so-called *classical* conditioning we have the sort of situation just described.

Responses often occur without application of an external stimulus. They are *emitted*. Scratching an ear, pecking, and pressing a lever exemplify such responses. In emitting them, the organism is, so to speak, operating on its environment, hence the term *operant*. Reinforcing an operant, as by following it with food, increases its frequency. An increased rate of response is the evidence that conditioning has occurred. Conditioning along these lines is said to be *instrumental* because the

response is instrumental in obtaining reinforcement.

Some of the important principles of classical conditioning are: More rapid conditioning when the conditioned stimulus precedes the unconditioned stimulus (and unconditioned response) by a brief interval. Stimuli resembling the conditioned stimulus in certain respects may also elicit the conditioned response — the principle of *stimulus generalization*. When two somewhat similar stimuli are presented, and only one of them is reinforced, *discrimination* develops. Now only the stimulus that was followed by reinforcement is effective. Repeated presentation of the conditioned stimulus without reinforcement produces *experimental extinction* — the response weakens, the conditioned stimulus loses its effectiveness. After an interval, however, there may be *spontaneous recovery* — a return of the previously extinguished response. The conditioned response often differs from the original response to the unconditioned stimulus — it may be abbreviated, as when the dog at first struggles when shocked but finally does no more than lift the shocked foot. *Anticipatory responses* may also occur. *Higher-order conditioning* can be obtained, as when a bell that has come to elicit salivation is substituted for food in developing a second conditioned response. This is an example of *secondary reinforcement* as well as second-order conditioning. In one form of instrumental conditioning an anticipatory response serves to escape shock. It is thus instrumental in avoiding the punishment. This is sometimes also referred to as *avoidance conditioning*.

Operant conditioning is instrumental, yet it differs from the instrumental conditioning just described. In avoidance conditioning a stimulus is used by the investigator to elicit a response, which he forthwith proceeds to condition. In operant conditioning there is no unconditioned stimulus — or at least none known to the investigator and capable of being used to elicit the response. The organism must emit the response — initiate it without experimental control — before it can be conditioned. The experimenter does, however, arrange certain contingencies — the sort of reinforcement that the response, once emitted, will bring. Thus, in pressing a lever, the contingency is food. Studies of operant conditioning have

shown that reinforcement following *any* response may condition it so that it occurs at an increasing rate.

In *reward training*, where pressing a lever or pecking at a disc is followed by reinforcement with food, various reinforcement schedules may be used, and with somewhat different effectiveness with respect to the rate of responding. Food may come at every response or it may come intermittently. Intermittent reinforcement may occur at fixed intervals (say, every minute), at fixed ratios (say, every fifth response), or at variable intervals or variable ratios. The highest rate of responding is found with variable intervals or ratios, for the animal then does not know after what interval, or after how many responses reinforcement will come.

Complete removal of reinforcement is followed by a slower and slower rate of responding. Spontaneous recovery may occur after an interval, as in classical conditioning. Continued absence of reinforcement finally produces experimental extinction. Secondary reinforcement is also found in operant conditioning, as when a click associated with food becomes an effective reinforcing stimulus and a chimpanzee works for poker chips which he can later exchange for food. Some attention was given to verbal reinforcement in human operant conditioning, as when personal opinions expressed in conversation were made more frequent by such reinforcement as "I agree with you." The potency of operant conditioning procedures in shaping behavior is especially evident in training which involves reinforcement of successive approximations to a desired response.

*Escape training* is an operant procedure which also has some of the aspects of classical conditioning. An electric shock produces escape movements. That is where the similarity lies. However, of many things that the subject may do, one and only one turns off the shock. This response is emitted. It is reinforced by cessation of the punishment. Like the response of reward conditioning, this response grows in frequency until, finally, it takes precedence over all other responses and is made immediately the shock comes on.

Although they may have much in common with conditioned responses, skills are obviously more complex. In studying acquisition of skills, we disturb the organism's adjustment, then observe its success in achieving a readjust-

ment. Mazes are widely used for this purpose. In a typical maze situation, the animal is prevented from getting food except by going from the entrance to the food box.

Learning curves not only give a graphic record of the progress of learning, but they are useful for comparative purposes. Increasing proficiency is indicated by a decrease in time, errors, or excess activity—or by an increase in correct responses. These changes are plotted as a function of trials, or practice periods.

As examples of typically human skills investigated in the laboratory we have referred to tracking (both compensatory and pursuit) and to such verbal skills as reciting memorized material.

Both animals and human beings solve detour problems, puzzle boxes and tool-using situations by an overt trial-and-error attack, but the latter are more likely to solve them by implicit trial and error and by observation. While animals below man sometimes solve such problems by grasping significant relations (using insight) and by copying the performances of others (imitating) they are more likely to use overt trial and error. Even where animals do learn problems by using insight and by imitating others, human beings solve problems of much greater complexity than the animals can solve on these bases.

Acquisition of complex skills may be facilitated by observation of skilled performance. This does not mean that the skills are learned by imitation alone; it means only that observation of skilled performance may short-circuit, as it were, some of the overt trial and error that occurs in learning. Such observation may also give insight that does not otherwise occur.

Both motor and verbal skills have different levels of complexity. We are often required to learn relatively simple habits and then to combine them into habits of increasing complexity. Typing, telegraphy, and many other activities of everyday life are habit hierarchies. It is noteworthy that, as higher-order habits develop, the simpler habits tend to become more automatic, which means that we are decreasingly aware of their presence.

There is much evidence that learning of some skills facilitates the acquisition of others

which involve similar contents, techniques, or principles. This is a positive effect, generally referred to as positive transfer.

Negative transfer effects, which are usually referred to as negative transfer or habit interference, are often found in motor and verbal learning. These effects are likely to occur when the contents, techniques, or principles already learned are the reverse of those required in new learning and when familiar situations require new responses.

Motivation is an important, and possibly an essential aspect of all learning. Experimental studies have emphasized such incentives as material rewards (food, money), praise, and social recognition. The relative effectiveness of different incentives depends upon the particular learner and also, to some extent, upon what is being learned. Knowledge of results adds to the efficiency of learning because it motivates and also because it facilitates repetition of correct responses and the correction of errors.

Distributed learning is generally more economical than massed learning. One possible reason is that, during a rest period, errors are forgotten faster than correct responses. Recitation is more economical than a mere reading of what is to be learned. One important reason is that recitation provides knowledge of how well, or poorly, one is doing.

Several principles of learning have broad significance. One of these is contiguity. Another is motivation. A well-motivated organism does something about the situation in which it finds itself. This opens the way for operation of another important principle—that of reinforcement. Primary reinforcement involves such incentives as food, water, and escape from punishment. Secondary reinforcement (such as a click or token associated with food, a kind word, or social recognition) is also very important for learning, and especially at the human level. What is reinforced is the association between a stimulating situation and the response contiguous with it. Except in rare instances, where simple acts or attitudes are learned, learning requires repetition, as when repeated trials are given.

Contiguity, by itself, is of doubtful significance. The same is true of repetition. What is important for learning is the repeated reinforcement of contiguous stimulus-response

relationships. This is most obviously true where conditioned responses and relatively simple skills are acquired. Some theorists believe that we shall eventually be able to account for all learning, of whatever complexity, in terms of a common set of principles, and

possibly those considered in this chapter. But it is altogether too early to predict the eventual outcome of learning theory, for a great deal of theoretically guided experimentation is still in progress and its results will eventually decide the controversial issues.

(References and notes for this chapter are on page 557 of the Appendix.)

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# Remembering and Forgetting

11

The memory trace · Nonverbal evidence of retention · The delayed reaction ·  
Verbal recall · Recognizing · Retention and original learning · Forgetting ·  
Why do we forget? · Summary

So far our discussion of the learning process has dealt with acquiring. Now, in turning to memory, we give special consideration to the retention and recall of what has been learned.

Remembering is retaining, although not necessarily retaining of which one is aware, as when he says that he remembers something or as when he sets out to memorize a poem, a lesson or a speech. Many of our learned acts are performed automatically, without any awareness of what we are doing. This is especially true of motor activities. In these instances there is also memory, but memory in the sense of neural retention without involvement of what we have referred to as "symbolic processes." Retention without awareness is sometimes referred to as "biological memory."

Without memory in at least the biological sense there could be no learning. Each occurrence of a situation would elicit the same response as before. On each trial the organism would, so to speak, "start from scratch." Instead of this there is, as we have seen, a more or less progressive change as training or practice continues. The organism responds to a previously neutral stimulus, there are more correct responses, a task is performed with a decreased expenditure of energy.

Forgetting is failing to retain or to be able to recall what has been acquired. As in the case of memory, forgetting may be evident to us or we may be unaware of it. Considered biologically, forgetting, like memory, is a necessary aspect of the learning process, for we must often "forget" incorrect responses while we acquire correct ones.

Thus learning, retaining, recall, and forgetting are interdependent processes. Whatever makes for good learning has this effect because it is conducive to good retention, which is of course the obverse of forgetting.

Remembering and forgetting vary in degree. To all appearances we may retain (or forget) some knowledge or some skill completely, partially, or not at all. We say "to all appearances" because it is impossible to prove that anything once learned is ever completely forgotten.

If you were asked to describe your earliest experience, you would recall events that, seemingly, had been completely forgotten before you began to probe the remote past. Your memories would most likely go no further back than your third or fourth year, although there are some authentic instances of memories going back as far as the first year.<sup>1</sup>

Memory for something may be complete, it may be partial, or it may, as far as appearances go, be negligible. In the latter instance, however, forgetting may still not be complete. Suppose, for example, that you learned a poem as a child. You may be able to recall it completely, reciting it word for word, just as you did as a child. Perhaps you cannot recall the poem, even partially, but you can recognize it as one learned in childhood. Among many other poems which you did not learn, it appears familiar. Perhaps you cannot even recognize the poem. But since you learned it as a child, the chances are that you will be able to relearn it with a saving in the repetitions required. That is to say, you memorize it now much more readily than you memorize poems of comparable difficulty which you never before learned. In this event there is some retention, small as it may be.

Evidence of memory comes from several sources. An animal or a human infant may reproduce some motor performance, it may relearn with a saving in time and effort some response which it cannot perfectly reproduce, it may respond in terms of some stimulus which has been present but which is absent at the time (like looking for a lost toy), and it may select from a random assortment of objects some object shown to it previously.

### THE MEMORY TRACE

Whenever we retain anything there must be a correlated change of some kind in the nervous system. This is often referred to as a "memory trace," a "neurogram," or an "engram." The word "engram" is probably the most general term that may be used for the intervening variable inferred to explain retention, without making any specific assumptions concerning the anatomical or other characteristics of cells that are modified. The possibility has been suggested that the engram is a modification analogous, in some ways, to the molecular changes in a magnetic tape which enable us to play back what was recorded. Pavlov's model of what takes place in the nervous system when a conditioned response is acquired involves the concept of new neural connections. Essentially the same idea has been held by some to account for verbal associations, as when a student learns that the French equivalent of *Man* is *Homme*.

In view of our ignorance of what actually takes place in the nervous system when we learn, some investigators prefer to make no assumptions about neural traces. With respect to the *Man-Homme* association, for example, they are satisfied to speak of the *associative strength* of the connection, by which they mean merely that, as practice continues, there is an increasing probability that, given the stimulus *Man*, the response *Homme* will follow.<sup>2</sup> They are perfectly satisfied to leave speculations about the nature of neural traces to neurologists.

Although most of what we know about retention and forgetting requires no particular assumption beyond the existence of a neural trace of some kind, it is interesting to observe what an eminent neurologist has to say about possible traces. He says,

Memory involves the making of an impression by an experience, the retention of some record of this impression and the re-entry of

this record into consciousness (or behavior) as recall and recognition. . . .

The human brain is composed of some 10 billion nerve cells, more or less alike, which interact in various ways. Each cell contributes to behavior, and presumably to mental activity, by firing impulses or failing to fire. All the phenomena of memory must be explained in terms of the temporal and spatial patterns of these discharges.

If experience is to modify behavior, the activity of neurons connected with an experience must alter their subsequent activity patterns. Two general questions regarding the neural trace must be asked, and both can be given a reasonable, if not a certain, answer today. The first is: Does memory depend on a continuing activity or on some static residue, some structural alteration, left behind by past activity? Is a river the water flowing in it or the channel the water cuts? The answer today is tending strongly toward the latter. The second question is: Is the structural trace (or dynamic process) for each memory located in a particular region, or are memory traces suffused through the brain in some way? Are memories marks placed on violin strings or are they wave trains playing over these strings? The latter would imply dynamic memory, but the trace would still be structural, like the wiggled groove on a phonograph record. Whether the trace is localized or diffuse, its exact nature is a third, if somewhat subsidiary question. Current investigations suggest that there are multiple patterns of local traces rather than a single well-localized one, but the nature of the trace is almost pure guess.<sup>3</sup>

In speaking of an engram, therefore, one refers in the most general way to whatever it is that underlies memory. This discussion is also relevant to forgetting because, when we forget, the trace must have been obliterated, or else rendered ineffective by something which interferes with its expression in behavior.

Our discussion of the memory process begins with nonverbal evidence of retention.

#### NONVERBAL EVIDENCE OF RETENTION

In animals (and in children before language develops) there is no evidence of retention

except through nonverbal behavior. This evidence comes from *reproducing* a performance learned some time earlier, and from the ability of the organism to *relearn* a skill in fewer trials, with fewer errors, or in less time than in learning it originally.

#### Reproducing a motor performance

Suppose, for example, that a rat or a human being has learned a maze to the criterion of three trials in succession without error. The next day, or a week or a month later, we may wish to see whether the habit has been retained. If the subject can traverse the maze for three trials without error, we say that it remembers perfectly—that there has been no forgetting.

Some rats have retained simple problem-box habits perfectly for as long as a month. Still higher organisms may retain such habits for months or years. Man retains some habits for life. You may not have ridden a bicycle for many years, yet still be able to ride one perfectly well.

How long we retain a motor habit perfectly depends to a large degree on how much we have practiced it. Skills like eating with a knife and fork, buttoning and unbuttoning clothes, and writing are practiced so frequently that, even if something should prevent us from practicing them for many years, they would be retained without noticeable loss.

The almost perfect retention of motor skills over long periods has led some to suppose that such skills are necessarily better retained than verbal skills. That this is not so has been demonstrated in experiments where predominantly verbal activities (memorizing nonsense syllables) and predominantly motor activities (learning mazes) have received equal repetition. Under these circumstances, retention of motor skills is no better than retention of verbal ones.<sup>4</sup>

It has been argued in this connection, however, that human maze performance involves verbal elements and hence that the investigators were comparing one verbal skill with a motor skill which was to a great extent verbal. Pursuitmeter learning (p. 286) is probably less verbalized than maze performance and more recent research has shown that, after equal practice, retention of this motor skill is

still far superior to retention of nonsense syllables.<sup>5</sup> It is possible that this superiority of the equally practiced motor task comes from its unitary, highly integrated character. The subject seems to be learning one instead of several things. A list of nonsense syllables, by comparison, consists of several things to be learned. It is piecemeal, or loosely organized. One might expect the more unitary task to show a greater resistance to disintegration during a period of no practice, hence have superior retention. But what happens when motor and verbal tasks are both closely integrated? A recent study involving operation of switches versus memorization of nonsense syllables arranged in a pattern corresponding to the switches was designed to answer this question. Retention of the motor habit was still superior, but not significantly so.<sup>6</sup>

The conclusion that one may draw from these studies is that the superior retention of motor skills in everyday life comes from the fact that many of them are overlearned (see p. 323) as compared with verbal skills, and also from the fact that they are better integrated. Still another reason for better retention of motor skills in everyday life is perhaps the fact that most of them are learned under better motivation than most verbal skills. One would expect, in short, that equally practiced, equally integrated, and equally interesting motor and verbal skills would be equally well retained.

#### Relearning as evidence of memory

Suppose that retention is not perfect. Some forgetting has occurred. But how much? The method of determining this is the *saving method*. It is used with animals and human beings.

In order to discover the degree of retention (or forgetting), we require that the task be relearned to the same criterion as that originally involved. Thus, if the maze was learned to the point where it could be traveled three times in succession without error, it is relearned to the same criterion. We then compare the original performance with the relearning performance.

Suppose, for example, that a rat required twenty trials to learn a maze and only five trials to relearn it some time later. The sav-

ing is fifteen trials, or 75 per cent of the trials originally required. From the standpoint of forgetting, the rat has forgotten 25 per cent. In one maze-learning experiment with rats, there was a saving in trials and time to relearn which averaged 90 per cent after two weeks, 88 per cent after four weeks, 85 per cent after six weeks, and 73 per cent after eight weeks.<sup>7</sup>

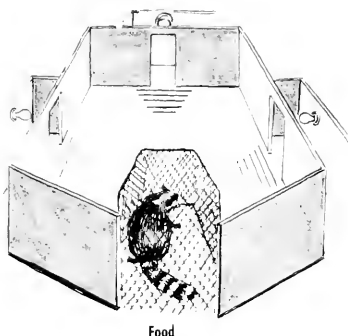
Subjects may learn verbal materials until they can be recited without error. Weeks, months, or years later, the material may be partially forgotten. In relearning it to the criterion of one perfect repetition, and in comparing the repetitions required with those originally involved, the amount or percentage of retention can be determined.

A saving in time and effort required for learning may occur even when the material was originally not learned to the point where it could be recalled, and even where there was no evident attempt to memorize it. This is illustrated by an experiment in which a psychologist read certain Greek passages to his child between the ages of fifteen and thirty-six months, and several years later required the child to memorize them. Some of the passages were learned at the age of eight and a half years, and others at the age of fourteen years. In each instance the repetitions required to memorize the material read to the child were fewer than those required to memorize new passages of equal difficulty. The average number of repetitions required at eight and a half years was 317 for learning the passages presented earlier and 435 repetitions for learning the new passages, a saving of 27 per cent. So hearing the passages in childhood, although it did not produce learning from the standpoint of recall, led to a saving of 27 per cent when learning to the point of recall was later required. The materials learned at fourteen years yielded a saving of only 8 per cent. Thus, the effects of earlier experience with the Greek passages apparently grew weaker with time.<sup>8</sup>

#### THE DELAYED REACTION

Tests of delayed reaction are used to obtain evidence of recall in animals and infants. The ability of an infant to respond to an absent stimulus in a delayed-reaction test signals the





Food

## 11.1 Hunter's Delayed-Reaction Apparatus.

This particular form of the apparatus was used with raccoons. The animal in the release box could be stimulated by the lights. It was required to associate a light, appearing in any one of the three doors in a chance order, with the presence of food. An electric shock was administered whenever the animal attempted to enter an unlighted chamber. Food was obtained at the front of the apparatus whenever the correct chamber had been entered. In the training series the release box was raised while the light was still present. After the association between a lighted compartment and food had been thoroughly established, the light was turned off before release. The animal was now required to remember in which compartment the light had appeared. If it continued to go to the previously illuminated compartment, a longer delay between the turning-off of the light and the raising of the release cage was instituted. The time of delay was gradually increased until the animal could no longer remember which compartment had been illuminated.

emergence of an elementary symbolic process. This point is elaborated in the following discussion.

In the original experiment on delayed reactions in animals the apparatus represented in Figure 11.1 was used.<sup>9</sup> The subject was first trained to associate a lighted compartment with food and an unlighted compartment with an electric shock. The lighted compartment

varied in position in a random sequence from trial to trial so that the problem could not be learned merely by going to the middle door, to the right-hand door, to the left-hand door, or to the three doors in any particular sequence. If it learned this part of the problem at all, the subject did so on the basis of response to the light.

After the subject came to select the lighted compartment at every trial, the delayed-reaction tests were instituted. The light was turned on in a compartment, but turned off before the animal was released. In order to respond to the previously lighted compartment, it was now necessary to remember in which compartment the light had been. If the interval between turning off the light and release was one minute, and the animal consistently went to the previously lighted compartment in a series of trials, it was credited with remembering for one minute—or, more specifically, recalling after one minute. The delay could then be increased until a marked inaccuracy of performance occurred.

Rats and dogs did not respond correctly after an interval of even a few seconds unless they kept their heads turned toward the correct compartment. This motor set—involving muscle tensions—enabled them to respond correctly. Raccoons and children, on the other hand, did not need to maintain a motor set. They moved around in the release box and, after it was raised, turned and proceeded toward the correct compartment.

In rats and dogs there was no evidence of response to an absent stimulus. Although the light was off, kinesthetic stimuli associated with the fixed position of the body were present to guide them. The raccoons and children, on the other hand, maintained no motor set—hence, they had neither the light nor kinesthetic stimuli for guidance. Controls showed that no other external stimuli were acting as cues. The investigator thus concluded that the raccoons and children were guided by some implicit process which represented the absent light. This he called a *symbolic process*. He defined the symbolic process as “any process which is a substitute, which can arouse a selective response, and which can be recalled if it ceases to be present.”

In the case of raccoons and children, some-

thing inside of the organism — presumably some sort of memory trace — substituted for the light. Its function was selective because it guided the animal to the previously lighted compartment — not to any or all compartments. The engram was presumably not functioning while the raccoons and the children were turning in this direction and that, but it was reinstated after an interval.

Rats and dogs, although they failed to exhibit the symbolic process in this situation, have given ample evidence of it in later research, with simplifications of the original technique.<sup>10</sup>

Current research on delayed reaction in animals and children utilizes a more direct method than that described. It is more direct in that the subject does not first have to be trained to associate a particular isolated stimulus (like the light) with food. For example, a monkey sits a short distance from the experimenter. Two cups are placed before it, one to the right and one to the left, or one near and one more distant. While the animal watches, the experimenter slips a piece of lettuce under one of the cups. The animal is now removed from the situation, perhaps taken to another room. Some time later it is returned to the experimental situation and released. If it goes directly to the food cup, the monkey is allowed to eat the lettuce and is credited with a correct response. If the correct cup is selected trial after trial, despite the fact that both cups smell alike, that the food appears under one cup at one time and another at another time, and that no other external cues as to the correct cup are available, we are forced to conclude that the animal remembers under which cup it saw the food placed some minutes or hours before.<sup>11</sup> Stimulation provided by the experimenter's placing of the food must leave an engram which later serves as a substitute for the actual stimulation. More about the nature of this symbolic process is suggested by a further experiment.

Monkeys ate lettuce if they found lettuce after seeing it placed under a cup, but they preferred bananas to lettuce. "What would the monkeys do," the experimenter asked, "if they saw a piece of banana placed and found lettuce when they returned to the situation?" When they found the lettuce under

these circumstances, the monkeys usually refused it. They left it where they found it and walked away. Sometimes they examined the vicinity as if looking for the missing banana. Temper tantrums were occasionally exhibited. Children behaved in a somewhat similar fashion when a nonpreferred reward like a chocolate drop was substituted for a jelly bean. Sometimes, however, they asked about the exchange of rewards.<sup>12</sup>

In testing for the development of symbolic processes during early childhood we use a relatively simple direct test of delayed reaction, such, for example, as requiring the infant to recall under which one of three plates a cookie has been hidden, with the cookie changing position from trial to trial.

The period of delay after which recall can occur tends to increase from lower mammals to human beings. In the latter, it increases during the growth period. An infant of one year may remember for only a few minutes, a child of five years for a month or more. Older children and adults may recall a particular event years later. Again we see the importance of neural maturation during early childhood. When language develops it helps to bridge the gap between an event and the occasion for recalling it.

Delayed matching in terms of a sample also tests recall in animals and children. Subjects are presented with a sample (Figure 11.2) and later required to identify it among a variety of other items. The monkey is first trained to lift an object in order to obtain food. Several objects are used in this way. Then he is taught to lift an object resembling whatever sample was shown. A triangle is shown and then removed. Several seconds or minutes later the animal is confronted with a triangle and several other forms. In order to be scored correct, he must now lift the triangle and not touch the circle, square, or other objects presented with it. A circle, let us say, is then shown. Later it is presented with other forms. Now the circle must be lifted and the triangle and other objects left untouched.<sup>13</sup>

When children are used in such experiments, they may be instructed to "find the form like the one I showed you a few minutes ago." They must then point to the form or other object resembling the sample.<sup>14</sup>



**11.2 Delayed Matching from Sample.** In the delayed matching-from-sample test, the object at the left is first shown by itself. It is then removed and the forms to the right are shown. In order to recognize which of these forms was seen earlier, the subject must remember what the original form was. Sometimes the forms are all of the same shape but different in color. At other times they may differ in both shape and color. Then the subject must remember not only the shape of the sample but its color as well. (Photos courtesy H. F. Horlow.)

### VERBAL RECALL

Delayed reaction tests, while useful in gauging the recall memory of animals and infants, are too simple for use with older children and adults. Recall at these levels is tested by using nonsense syllables, words, digits, or more complicated verbal or symbolic materials.

The simplest type of recall test with verbal materials is found in memory span tests. The subject may be presented with a series of digits gradually increasing in length. Each list is given only one presentation. When the auditory memory span for digits is tested, the digits are read off by the tester. As soon as the end of the series is indicated, the subject tries to repeat the digits vocally or in writing. Thus if the experimenter reads, "0 4 1 6 2 8 5," the subject attempts to reproduce these numbers in correct order.

The first series may have four digits, the next five, the next six, and so on up to a series of a dozen, as in the following sample, which you may use to test your own or another's memory span.

7152  
16529  
531584  
9152693  
86103279  
726394105  
6574398961  
40315806296  
374691705824

The memory span for digits is the longest group of digits one can recall in correct order, regardless of the length of the series read to him. He may recall the entire series until he gets to six or seven; but he may get eight out of the list of a dozen. His span for that presentation is then eight. The span will differ somewhat from presentation to presentation, hence an average of several tests is often taken.

When the visual memory span for digits is measured, the subject is shown the digits, one at a time, perhaps in the window of an apparatus like that illustrated earlier (p. 288). He then recalls them orally or in writing.

The same general procedure is used in testing the visual memory span for words, syllables, forms, or other materials.

Memory span differs with the individual (see p. 115), with age, and with the type of material used. For example, the average span for auditory presentation and vocal recall of digits is four between four and five years, five between six and eight years, six between nine and twelve years, and seven beyond twelve years.<sup>15</sup>

When familiar objects are presented, one at a time, and named by the child as they appear, his memory span is about five at five years and eight at thirteen years.<sup>16</sup>

#### Learning lists of items

If a list of items, like the nonsense syllables below, is to be memorized, they may be read from beginning to end until the subject feels that he can recall the entire list, or they can be learned by the *anticipation method*. That is, JEK may be exposed and the subject guesses (anticipates) the next syllable. If he responds with SUT, he is credited with a correct anticipation, SUT is exposed, and he anticipates the next item. This is continued until every syllable is correctly anticipated.

JEK  
SUT  
DOX  
LIF  
GAJ  
SEK  
BAF  
CIV

As learning of such a list continues, the frequency of SEK in response to GAJ increases. In other terms, we may say that there is an increasing probability that the response SEK will follow the response GAJ. This is what investigators mean when they say that the *associative strength* of the connection between GAJ and SEK has increased.

The reader will doubtless have noted that the anticipation method involves a recitation procedure

#### RECALL OF PAIRED ASSOCIATES

Suppose that the following pairs of English words and transliterated Russian equivalents were shown, one pair at a time, and you

were asked to learn the Russian associate of each English word:

SKULL	CHEREP
EYE	GLAZ
SKIN	KOZHA
BRAIN	MOZG
FOOT	NOGA
HEAD	GOLOVA
MOUTH	ROT
BONE	KOST
HAIR	VOLOS
BACK	ZAD

After one repetition of the list of associates, you might be given the first members of the pairs in a changed order and asked to recall their associates. You might recall a few of the Russian words after this single presentation, but you would not recall all of them. After each successive repetition of the pairs, however, you would probably recall more associates. Finally, you would be able to recall the Russian equivalent of every English word.

The anticipation method is also applicable here and, again, there is an increasing probability, as learning continues, that, for example, the item HEAD will elicit the response GOLOVA.

#### Recalling narratives

Children and adults read or hear narratives which they later attempt to recall, either orally or in writing. Recall after a single reading is like a test of memory span, although connected rather than disconnected material is involved. When the narrative is read or heard repeatedly and a recall is required after each repetition, we have something like the typical memory experiment in which increased retention occurs as a function of repetition. A learning curve may be plotted for such data. Sometimes, however, recall is required at intervals of minutes, hours, days, or weeks, after a single presentation of the narrative. This is to see how forgetting proceeds, and whether or not distortions are introduced as a function of time and repeated recall. A still further variation of memory experiments with narratives is to have one individual read or hear the narrative, then tell it to another who, in turn, tells it to still another, and so on. In

this way, changes introduced as the story passes from one to another, as when rumors pass from mouth to mouth or legends are handed down, may be investigated.

In one extensive investigation involving the above procedures, university students read stories, then attempted to reproduce them.<sup>17</sup> For example, a student read the following story two times, then engaged in other activities for fifteen minutes. His reproduction after fifteen minutes follows the original story.

#### ORIGINAL STORY

##### *The Son Who Tried to Outwit His Father*

A son said to his father one day: "I will hide, and you will not be able to find me." The father replied: "Hide wherever you like," and he went into his house to rest.

The son saw a three-kernel peanut, and changed himself into one of the kernels; a fowl coming along picked up the peanut and swallowed it; and a wild bush-cat caught and ate the fowl; and a dog met and caught and ate the bush-cat. After a little time, the dog was swallowed by a python, that, having eaten its meal, went to the river and was snared in a fish trap.

The father searched for his son and, not seeing him, went to look at the fish-trap. On pulling it to the riverside, he found a large python in it. He opened it, and saw a dog inside, in which he found a bush-cat, and on opening that he discovered a fowl, from which he took the peanut, and breaking the shell, he then revealed his son. The son was so dumbfounded that he never again tried to outwit his father.

#### REPRODUCTION

##### *The Son Who Tried to Outwit His Father*

A son one day said to his father: "I will hide, and you will not be able to find me." His father replied: "Hide wherever you wish," and went into the house to rest.

The son saw a three-kernel peanut, and changed himself into one of the kernels. A fowl saw the peanut and ate it. Soon afterwards a bush-cat killed and ate the fowl, and then a dog chased and finally killed and ate the bush-cat. After a time a python caught the dog and swallowed it. Soon after its meal, the

python went down to the river and was caught in a fish-trap.

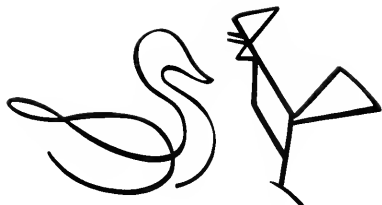
The father looked for his son, and when he could not find him, he went to the river to see whether he had caught any fish. In his fish-trap he found a large python which he opened. In it he found a dog in which was a bush-cat. On opening the bush-cat, he found a fowl, in which he found a peanut. He opened the peanut, and revealed his son.

The son was so dumbfounded at being discovered that he never tried to outwit his father again.

Observe that the reproduction retains the theme of the story and the succession of events. However, certain words, like the "wild" bush-cat, are omitted entirely; synonyms for others, such as "wish" in place of "like," are given; and some words — and ideas — are added which were not in the original. For example, the original does not say that the fowl was killed and eaten by the bush-cat "soon after" the fowl ate the peanut. All it says is that the bush-cat caught and ate the fowl. After successive repetitions of such materials, each recall gives more and more details and, in general, accurate reproduction is approximated. But when successive recalls by the same individual occur without any further presentation of the original, increasing distortion of details is introduced.

Some of the investigator's conclusions from his analysis of a mass of such data are: (1) "accuracy of reproduction, in a literal sense, is the rare exception"; (2) "the general form, or outline, is remarkably persistent, once the first version has been given"; (3) "style, rhythm, precise mode of construction . . . are very rarely faithfully reproduced"; (4) . . . "omission of detail, simplification of events and structure, and transformation of items into more familiar detail, may go on almost indefinitely"; and (5) "in long-distance remembering, elaboration becomes more common in some cases . . . and there may be increasing importation or invention . . . aided by the use of visual images."

When the individual reads or hears a narrative, then tells it to another, and that one tells it to still another, and so on, the theme may be retained, but there is usually a marked distortion of details. The following



COCK AND SWAN  
Original



COCK AND SWAN  
Drawing from memory

**11.3 Reproduction of Form.** This is typical of experiments on memory for form. The subject was shown the original drawing and, after it had been removed, asked to reproduce it. Observe that the general features, or themes, have been retained but that certain details have been changed or omitted. (After experiments in the book, *Remembering*, by Frederic C. Bartlett.)

reproduction of "the Son Who Tried to Outwit His Father" illustrates the point. It was obtained from the twentieth person who had heard the story, so to speak, chain fashion:

A small boy, having got into some kind of mischief, wished to hide himself from his father. He happened to be standing under a tree, when an acorn fell to the ground, and he immediately determined to hide himself within it. He accordingly concealed himself within the kernel. Now a cat chanced to be passing along that way, and when she saw the acorn, she forthwith swallowed it. Not long afterwards a dog killed and ate this cat. Finally the dog himself was devoured by a python.

The father of the boy was out hunting one day when he met the python, and attacked and slew it. On cutting the beast open, he discovered the dog inside it, and inside the dog the cat, and inside the cat the acorn. Within the acorn he found his long-lost son. The son was overjoyed at seeing his father once more, and promised that he would never again conceal anything from him. He said that he would submit to the punishment he deserved, whatever his crime might be.

#### Reproduction of forms

In Figure 11.3 are shown two figures and their reproduction after they had been ob-

served for one minute. An experiment on the memory of college students for such forms was conducted along the lines of the experiment on narratives. Successive repetition brought an increasingly faithful reproduction of the original. However, successive reproduction after only one presentation brought omissions, additions and inaccuracies reminiscent of those found when narratives were repeatedly recalled. The main outline or general schema was retained. For example, if a man was pictured, the reproduction was of a man, although markedly different from the original. One tendency which stands out in such reproductions is that the reproduction becomes increasingly conventional. This is also true when, as in the case of narratives, the picture is passed on, chain fashion, to a number of subjects, each of whom reproduces it from memory and then shows his reproduction to another.<sup>18</sup>

#### Testimony

Many studies have been made of the ability of children and adults to describe or otherwise report events witnessed just once. The situation is somewhat like that of testifying about accidents or other events while in a courtroom. Still or moving pictures may be used. Sometimes, however, a carefully rehearsed scene is enacted before the group, without any knowledge on their part that it is

acted, and without any expectation, either, that they will be called upon to testify concerning the event.

Thus, while Erle Stanley Gardner was addressing a class in legal evidence at the University of California at Los Angeles

a woman burst into the room and rushed at him shouting "you got my brother hung!" She then unsuccessfully attacked him with a pointed can opener before being escorted from the room by the regular instructor . . . who planned the stunt to dramatize the great variance of eye-witness accounts to the same event. . . .<sup>19</sup>

Descriptions of still pictures, movies, scenes enacted, or actual events are in most instances grossly inaccurate, and they become increasingly so with a lapse of time between the original experience and the reproduction. With respect to the above incident, thirty-four students were asked to describe the woman's complexion. Three said "dark," two "ruddy," one "medium," five "fair," seven "pale," three "heavily powdered and made up," and thirteen said they did not know. Actually, she was fair, had freckles, and wore no makeup.\*

You may test your own accuracy of recall in the following way: Some time ago you looked at a picture showing Charcot demonstrating hypnosis. Before looking at the picture again, write a description of it. Better still, show the picture for one minute to someone who has not already seen it. Then have him recall it in writing. Comparison of what is recalled with what was actually witnessed will undoubtedly show much discrepancy.

Sometimes the subject is given a list of statements or questions concerning the scene witnessed. He then attempts to say whether the statements are true or false, or to answer the questions. Recall in these terms also shows much inaccuracy. The degree of inaccuracy is often related to the way in which the question is framed.

Test yourself or your subject with the following statements about the Charcot picture.

\* Psychology has played a big part in the understanding of legal processes. *On the Witness Stand* by Hugo Münsterberg (McClure, 1908) was a pioneer contribution to this field. Some other references appear in the selected readings.

Each statement is to be labeled true or false.

1. Charcot has a beard
2. He is assisted by two male attendants
3. The hypnotized subject is female
4. Charcot is making passes in front of the subject's eyes
5. A stretcher appears in the picture
6. Charcot wears a long white coat
7. The audience is a class of young medical students
8. Tables and chairs are shown in the picture
9. The subject is standing erect
10. The room has two windows

Inaccuracy of recall, under circumstances like the above, has several possible bases. (1) Observation is perhaps incorrect in the first place, leading to omission of certain details and the addition of others. (2) Interests, attitudes, and expectations of the observer may influence both observation and recall. He may, for example, expect that a hypnotist will be making passes with his hands before the subject's eyes, hence erroneously recall such a detail. (3) Unintentional elaboration or exaggeration may be involved, as in the recall of narratives already considered. (4) As time has elapsed, there may be actual forgetting of details that were witnessed correctly at the time. Moreover, when forgetting occurs, there is a tendency to fill in gaps. Anything which seems reasonable in the light of what is remembered may be "recalled." This is one basis of the exaggeration mentioned above. (5) The individual may be misled by suggestions. When asked, "Did the man have on a dark or a light tie?" he may answer, "light" or "dark" even though the man wore no tie. Any or all of these shortcomings may be responsible for the omissions and errors so often involved in courtroom testimony. They are also relevant with respect to rumor, which is discussed in Chapter 16.

#### Eidetic imagery

Sometimes, especially in a large proportion of children under six years of age, testimony is exceptionally accurate — almost as accurate, in fact, as if the child could still see a picture after it has been removed. The child reports that he still *sees* the picture. These exception-

ally accurate "memory images" have been called *eidetic*, a term which suggests that they possess the clearness of hallucinations.\*

The most common test of eidetic imagery is to present some very detailed picture, then remove it and ask the child to describe what he sees, or to answer questions concerning it. The eidetic child seems to project the picture on any convenient surface and to describe what he sees. Acoustic as well as visual images are sometimes reported.<sup>20</sup> A child with acoustic eidetic imagery will repeat long lists of digits after hearing them once. As described to me by a colleague, one eidetic child looked at the desk while a list of a dozen or so digits was being read to him, then "read" the list off forwards and backwards while still looking at the desk.

Eidetic imagery is rarely present in older children and adults. Something akin to it perhaps exists in people who report a "photographic memory" like a student who told me that, after reading an assignment, she could see the material before her and "read" it again in imagination.

#### The role of stimuli in recall

In discussing the delayed reaction, we pointed out that the subject recalls an absent stimulating situation. This does not mean, however, that recall is without stimulation. The point is that the part of the situation recalled is absent. Other stimuli are necessary for recall. Thus, in the experiment with raccoons, the light recalled was not present at the time, but the experimental situation with its three compartments, the hunger of the animal, and other extraneous yet associated stimulating factors were present. In an entirely different external situation, or in the same external situation when not hungry, the animal in all probability would not recall the light.

*Stimuli for recall may be external or internal.* You may see a redheaded girl, and the redness of her hair may make you recall a childhood sweetheart whose hair was red. You

\* In hallucinations the individual sees, hears, or feels things that are not actually present, yet he believes them to be present. The person with an eidetic image, even though it may be as clear as an hallucination, does not necessarily believe it to be a perception of things actually present.



**11.4 Recall in terms of Reduced Cues.** If you fill in the missing parts, arms and face, mentally, you are recalling (or perceiving) in terms of reduced cues. (Courtesy Shuron Optical Company.)

may smell the odor of some flower that once grew in your home garden, then recall the garden. These, and innumerable examples that one might give, illustrate recall elicited by an external stimulus.

But you may have a stomach-ache and recall the green apples you ate as a child. You may be nauseated for some reason and recall that trip across the Atlantic during which you were violently seasick. These instances illustrate recall elicited by internal stimuli.

*Recall of one experience often leads to recall of another.* This phenomenon is sometimes referred to as *free association*. When we indulge in free association, we may recall many early experiences which we have not recalled for years. The success of psychoanalysts in getting better recall of childhood experiences than normally occurs comes from their use of free association. They have their patients "think out loud" and sometimes keep them at it during



séances spread out over months or years.

**Reduced cues.** Any fraction of some previously experienced situation may, by itself, lead to recall of a whole experience. This phenomenon is variously referred to as *redintegration*, *recall in terms of reduced cues*, or *response to minimal cues*. As illustrated in Figure 11.4 our redintegrative ability enables us to recall (or perceive) a whole situation in terms of significant parts. To use our previous illustration, red hair, the odor of a perfume, the sound of footsteps, or any other single aspect of some friend, may lead to complete recall, not only of a friend, as such, but also of former experiences to which she contributed. In delayed reaction situations (pp. 312-315) the present stimuli apparently serve to redintegrate the absent ones so necessary to the correct response.

### RECOGNIZING

Recognizing is much easier than recalling. This is why examinations of the matching and multiple-choice variety are easier than completion tests in which blanks are left to be filled in or essay examinations covering the same material. When the student has all the material before him, he does not have to recall it. His task is merely to differentiate between the familiar and the unfamiliar, or what has been experienced before and what is new.

In the typical experiment on recognition memory, a subject is shown nonsense syllables, words, forms, or other simple materials. He is given one or more complete presentations, the items usually being presented one at a time as in experiments on recall. The items involved in these trials are then presented among new items, the new and the old being mixed up in a random order. Now the subject must indicate which of the items appeared originally.

You may try this test yourself. Examine each of the faces in Figure 11.5, allowing yourself one minute for the whole group. Then turn to page 491, and record the number of every face that you recognize as having been in the first group.

So-called *false recognition* is another example of response to reduced cues. We may "recognize" a person as our friend because of some similarity to the friend, such as hair-color, walk, build, or dress. Some aspect of former stimu-

lation involving our friend leads us to recall him, and at the same time to identify the present person with the one recalled. The feeling that one has been in a certain place before or that he has done or said something before, even though he knows that this is the first time, has a similar basis. It is often referred to as the *déjà vu* experience. Something in the present situation or present behavior may be identical with, or very much like, something that occurred previously. This present aspect of former stimulation or activity leads us to recall the original experience and we incorrectly identify it with the present one. False recognition of this sort may be basic in the report of many mystic experiences in which individuals believe that they have recognized persons known in some previous incarnation.

### RETENTION AND ORIGINAL LEARNING

Any activity which produces a poor impression obviously yields poor retention. The poorly motivated subject learns little, and, when tested for retention, later, retains little. But even where motivation is good, the most economical method of learning usually yields the best retention.

We have already considered how distributed practice and recitation facilitate learning. Now we see that they also improve retention.

#### Distributed versus massed learning

Thirty-two college students memorized lists of nonsense syllables to the point where they could recall the list perfectly. They learned comparable groups of syllables by the distributed and by the massed method of practice. Some lists were recalled after an interval of ten minutes, and still others after an interval of twenty-four hours. The same lists were then relearned to the original criterion—namely, one perfect repetition. The results were quite clear-cut. After every interval, the average recall score for distributed practice was higher than the recall score for massed practice, despite the fact that learning with distributed practice involved fewer repetitions. There was a suggestion, too, that the difference in favor of distributed practice be-



**11.5 Test for Recognition Memory.** Look at these faces for one minute; then turn to p. 491 of Appendix and see how many you recognize. (Courtesy Brunswick High School and the Pierce Studio.)

came greater as the interval between original learning and recall increased. In terms of repetitions required to relearn, distributed practice was again better than massed practice. As in the case of recall, this was true after each interval between learning and relearning. Although the above discussion refers to group averages, most individuals also recalled more and relearned faster when practice was distributed.<sup>21</sup>

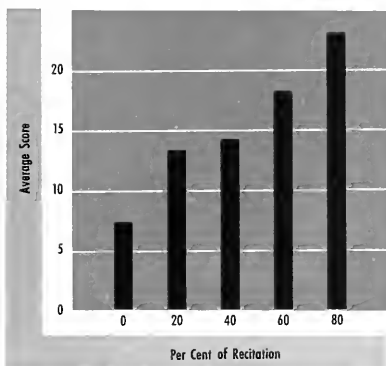
in which the most efficient learning (immediate retention) of nonsense material occurred with 80 per cent recitation. The most efficient learning of biographical material was obtained with from 40 to 90 per cent recitation. It is interesting to observe, therefore, that retention after four hours was best for the percentages of recitation which had already proved most efficient in learning. The retention scores for nonsense syllables are shown in Figure 11.6.

#### Recitation

We have already described an experiment<sup>22</sup>

#### Speed of learning

It has often been claimed that slow learners



**11.6 Retention of Nonsense Syllables as a Function of Recitation.** Note that the retention score increases with each increment of recitation. (Data from A. I. Gates.)

retain better than fast learners who, of course, require fewer repetitions to learn. But this is a difficult question to investigate and the outcome varies with methods of investigation. One method favors the slow learner by giving him as much time as he wants, hence an opportunity to overlearn. Another method favors the fast learner. This sets a given learning period that is equal for both the fast and slow learners. Obviously, the fast learner will learn more in the time allowed, hence have more to retain. Consequently his retention score will be higher than that of the slow learner. When overlearning is prevented (by withdrawing each item as soon as it is learned) and the amount learned is equated (by terminating the learning session as soon as a certain number of items are learned), the fast learners are still ahead.<sup>23</sup> It is possible, however, that the fast learner, even though he learns only the items acquired by the slow learner, has them impressed upon him more strongly; that is, they may have greater *associative strength* for him than for the slow learner. Using a statistical technique too elaborate to describe here, it is possible to compare the retention by fast and slow learners of items having equal associative strength for each at the end of the learning

period. When this is done, fast and slow learners retain these equally well.<sup>24</sup>

What does this mean? It means that, in a situation where every variable except retention *per se* is held constant, fast learners retain as well, but no better than, slow learners. In the uncontrolled situations of everyday life, fast learners retain *more* than slow learners only when they learn more, or learn it better.

The slow learner, however, may obtain a relative advantage by overlearning.

### Overlearning

Suppose that twenty trials are required to memorize some material so that you can recall it correctly just once. What would be the advantage, if any, of having an extra ten trials — 50 per cent of overlearning? Would you retain 50 per cent better than without it? Ebbinghaus and several later investigators have found that there are decided advantages from overlearning.

Its value for retention is illustrated by an experiment in which adult subjects learned lists consisting of twelve monosyllabic nouns. They learned with different amounts of repetition beyond that required for the first perfect recall.<sup>25</sup> The criterion of learning was one perfect repetition of the list. Having one half as many repetitions again as were required to reach the criterion was designated 50 per cent overlearning. Having twice the number of repetitions required for learning was 100 per cent overlearning. Thus, if four repetitions allowed the subject to reach the criterion of learning, six repetitions would constitute 50 per cent overlearning, and eight repetitions 100 per cent overlearning.

Different groups learned comparable lists of nouns, with 0, 50, or 100 per cent overlearning. Recall and relearning occurred (in different groups) at intervals of one, two, four, seven, fourteen, and twenty-eight days. Figure 11.7 shows the retention curves for recall when overlearning was 0, 50, and 100 per cent. Somewhat similar results were found in the case of repetitions saved during relearning.

It is quite clear from these data that larger amounts of overlearning bring larger degrees of retention. If we consider recall scores after the interval of a day, we find that there was 26 per cent retention for 0 overlearning,

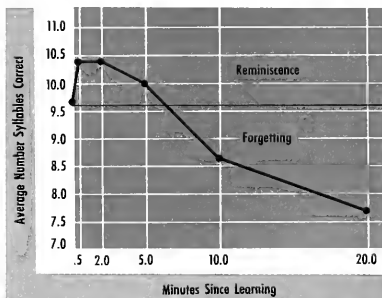
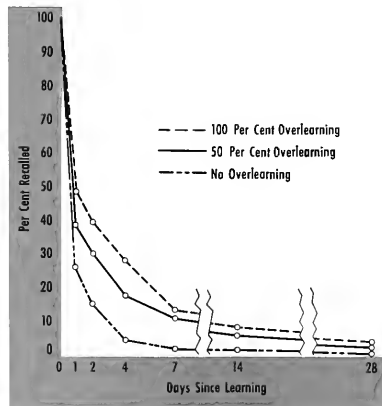
38 per cent for 50 per cent overlearning, and 49 per cent for 100 per cent overlearning. Taking the results as a whole, the increase from 50 to 100 per cent overlearning (a 33 per cent increase in the number of repetitions) brought less than a 33 per cent increase in retention. Thus diminishing returns were evident. This fact is apparent in the curves. Note that there is a wider space between the 0 and 50 per cent than between the 50 and 100 per cent curves.

A later investigation followed the same experimental design, but involved mazes instead of words.<sup>26</sup> The results were in fairly close agreement with those already indicated. In this study, however, 200 per cent overlearning was also introduced. The results show quite clearly that diminishing returns occur as overlearning is increased. For example, an increase of 100 per cent overlearning (100 to 200) brought an increased retention which averaged less than 50 per cent.

#### Reminiscence

In all of the experiments so far considered, the material was learned completely before retention was tested. A list of nonsense syllables, for example, was learned to the point where

### 11.7 Retention as a Function of Overlearning. (After Krueger.)

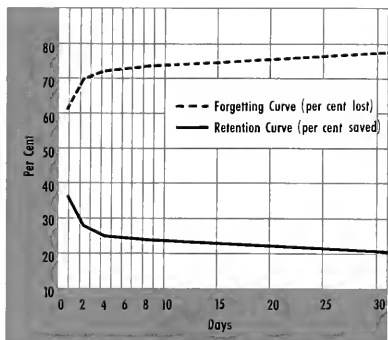


### 11.8 The Phenomenon of Reminiscence. (After Ward, L. B.)

it could be recalled with an accuracy of 100 per cent. Suppose, however, that it had been learned to an accuracy of only 70 per cent. Quite obviously, there can be no better retention than 100 per cent of something completely learned, but it is conceivable that a person who learned something so that he could give a performance that was 70 per cent accurate might perform later with an accuracy greater than 70 per cent. Indeed, there are many experiments which show that this is the case. Better retention of *incompletely* learned material after a rest interval than immediately after learning has been found in experiments with children, human adults, and animals, and using both motor and verbal skills.<sup>27</sup>

Improved retention after an interval has been called *reminiscence*. It is illustrated graphically in Figure 11.8, which represents the retention of an incompletely learned list of nonsense syllables by college students.

Reminiscence is perhaps related to the phenomenon of better learning and retention after distributed than after massed effort (pp. 300-302) and also to the well-established fact that interrupted activities are recalled more frequently than completed activities.<sup>28</sup> The explanation of these apparently related phenomena is not clear. It is possible that rehearsal of the material during an interval accounts for some reminiscence, but this still occurs when rehearsal is prevented, by having the subjects perform some other activity during the interval.



**11.9 Retention and Forgetting Curves for Nonsense Material.** Two curves are shown to illustrate the fact that retention is the obverse of forgetting; or, put otherwise, that forgetting is "negative retention." (Data from Ebbinghaus.)

It also occurs in learning by rats, which could hardly be credited with an implicit rehearsal of what has been learned.<sup>29</sup> Perseveration, and consequent consolidation of the memory trace (see p. 301) could conceivably account for some reminiscence, but the fact that it occurs when other activities intervene rules out perseveration as a necessary basis. The explanation stressed in recent discussions is one already mentioned in connection with distributed learning—the marked tendency for incorrect, hence interfering, associations to drop out during a rest period.

Reminiscence is, of course, only a temporary improvement in retention. It is followed by a more or less rapid loss such as occurs after completed learning.

## FORGETTING

Forgetting is the loss, permanent or temporary, of the ability to recall or recognize something learned earlier. In certain instances it may be described as negative retention. A retention curve drops as a function of time. Such curves are customarily used to represent the course of forgetting. If forgetting were plotted directly, in terms of the amount forgotten as a function of time, the curve would

rise rather than fall. For comparison of retention and forgetting curves based upon the classical experiment of Ebbinghaus see Figure 11.9.

Ebbinghaus memorized many lists of nonsense syllables by reading them through until one perfect repetition was possible. He relearned certain lists twenty minutes after he had memorized them. Other lists were relearned a day after, some two days after, and so on. Some of the intervals used, and the savings in time to relearn, appear in the figure. About 47 per cent was forgotten in twenty minutes, 66 per cent in one day, 72 per cent in two days, 75 per cent in six days, and 79 per cent in thirty-one days. Thus the forgetting of nonsense syllables was at first rapid (47 per cent lost in twenty minutes) and then slow (only 32 per cent more lost in a month).<sup>30</sup>

Later investigators, using many subjects and averaging the results, have verified the general trend of the forgetting curve found by Ebbinghaus for nonsense syllables; i.e., a relatively high rate of forgetting at the outset. In general, however, these investigators have found less overall forgetting than Ebbinghaus reported. One recent study showed only a 12 per cent loss after twenty minutes as compared with the more than 40 per cent loss found by Ebbinghaus.<sup>31</sup>

There are several reasons for such differences. Ebbinghaus used only one subject, himself. Individual differences could thus account for some of the discrepancy between his results and those obtained with other subjects, and especially since the data for many were, in later experiments, averaged. Perhaps of greater importance than this is the fact that Ebbinghaus learned thousands of syllables in the course of his experiments. This being so, it is quite likely that many syllables learned in earlier experiments interfered with later learning and retention, thus making for more rapid forgetting than would occur in the case of subjects learning (and later relearning) only one list. Such interlist interference has been avoided in recent research by having each subject learn only one list, then relearn it after an interval. This means, of course, that a different group is represented in the relearning at each interval. The list is learned, let us say, by 100 subjects. Twenty of these relearn after 20 minutes, 20 after one day, 20 after two days, 20 after five days, and the remaining 20 after a week.

Under these conditions, forgetting is much less, at any interval, than Ebbinghaus found.

Forgetting also varies with the method used to test it. The above comparisons were based upon the relearning (or saving) method. Had the subjects merely been asked to recognize the syllables (to identify them in a list including many others), little or no forgetting would have been evident. In a recent investigation with college students, all syllables of a 12-syllable list were recognized after an interval of 20 minutes and there was an insignificant loss after one and two days.<sup>32</sup>

Another retention test requires the subject to anticipate the first syllable of the list, then the next, and so on until all can be repeated without prompting. This is the anticipation method described earlier (p. 316). In the study referred to above, this method uniformly yielded lower mean retention scores than the recognition method. For example, 8.90 as compared with 12.00 after 20 minutes, and 6.80 as compared with 11.90 after one day.

Quite evidently, then, one cannot make a general statement about the course of forgetting—he must specify, among other things, the method used to test it.

Something needs to be said, also, about forgetting in relation to meaningfulness. Ebbinghaus demonstrated, and others have verified the fact, that meaningful materials (words, poems, narratives) are more easily learned, unit for unit, than nonsense syllables. Even among “nonsense syllables” there are some with greater meaning than others. Thus YIL has more meaning than XUY. Syllables with high meaning value are usually learned more readily than those with little or no meaning. But what about forgetting? Is there a difference in the forgetting of meaningful and meaningless material? One difficulty in answering such a question has already been indicated in the discussion (p. 322) of fast and slow learners. Since meaningful material is learned in fewer repetitions than nonsense material, the former may, at the same criterion of learning, have weaker associative strength. But when the associative strength of materials differing in meaning value is equated, there is equal forgetting. The items involved in these comparisons have been nonsense syllables with different meaning value<sup>33</sup> and also words and nonsense syllables.<sup>34</sup>

Failure to find a difference in retention as a function of meaning runs counter to everyday observation. However, one must remember that what is involved in these experiments is rote learning of a more or less artificial character. In daily life, the more meaningful aspects receive much support from many activities.

When complicated material is learned, especially material involving insight and the understanding of principles, there is a quite positive relation between meaning and retention. With insight (or understanding), early forgetting is seldom found. For example, college students learned various puzzles (match tricks) either by memorizing the solutions or by memorizing the principles involved. The majority of those who memorized without understanding the principles exhibited marked and rapid forgetting within a month. On the other hand, most of those who learned the principles had almost perfect retention when tested later at intervals up to one month.<sup>35</sup>

#### WHY DO WE FORGET?

There is no single nor simple answer to this question. Many variables are involved in forgetting and some are difficult to explain.

One should note, at the outset, that what appears to be forgetting may occur because there was no impression, or an inadequate one, in the first place. This was discussed in relation to errors of omission in testimony (p. 319). By the same token, much that we learn incidentally is poorly retained because there was only a weak impression. We frequently fail to remember names because we pay little or no attention when we hear them. Inability to remember what happened during an exciting or disturbing event is likewise due, in part at least, to inattention. This type of “memory loss” is sometimes referred to as *anterograde amnesia*. It is in contrast with forgetting of what occurred before the disturbing event, or *retrograde amnesia* (p. 257). This should not be confused with retroactive inhibition (see p. 332), which involves an interference by new learning with what was learned earlier.

Experimental extinction in conditioning (p. 275) is also followed by a loss that, in certain ways, resembles forgetting.

But suppose that learning has actually oc-

curred, there has been no emotional upset, and that experimental extinction has not been attempted. Why, even under these circumstances, does forgetting occur? That is the question to which we now address ourselves.

### The time variable

It is commonly assumed that lapse of time in itself is responsible for forgetting. According to this view, the memory trace, unless it is used, gradually deteriorates. Beyond a certain plausibility, however, this explanation finds little scientific support. Perhaps the strongest support comes from general observations such as the following:

The child who has normal vision for the first two years of life or thereabouts and then becomes blind loses all the effects of visual learning; at maturity he is indistinguishable from the congenitally blind. . . . Early visual learning, therefore, is reversible; forgetting can occur by disuse. Clinically, however, it is known that if the human subject has had vision long enough its effects do not disappear. If the child does not become blind until the age of four or five, the learning becomes more "ingrained" and disuse has little or no effect; in these circumstances, the subject never becomes like the congenitally blind.<sup>36</sup>

One difficulty with such evidence is that activity, other than visual, may itself have weakened the memory traces. Moreover, as will become apparent later, memories which were apparently lost may be recovered by appropriate stimulation, including direct stimulation of the cerebral cortex. It is thus possible that the early visual engrams, although not evidenced in performance, are still present.

Other observations suggest that time may be a factor in forgetting only because of the activities which occur in time. It has been demonstrated quite clearly that sleep and other forms of relative inactivity slow down the forgetting process.

### Sleep

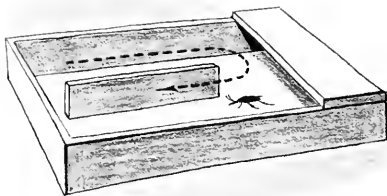
Two subjects memorized lists consisting of ten nonsense syllables before a period of (1) normal daily activity or (2) sleep. Retention

was tested after one, two, four, and eight hours of either waking activity or sleep. Under each of these conditions different lists of nonsense syllables were learned and recalled, but they were all of comparable difficulty. Each duration of sleep yielded better retention than a comparable duration of waking. After the successive intervals of sleep, the percentages of nonsense syllables recalled were: 70, 54, 55, and 56. There was, as we see, no further forgetting after the one-hour interval of sleep. The comparable percentages for waking were: 46, 31, 22, and 9. Forgetting was greater, the longer the interval of waking. These findings have been verified in later research. The investigators concluded that "forgetting is not so much a matter of the decay of old impressions and associations as it is a matter of the interference, inhibition, or obliteration of the old by the new."<sup>37</sup>

The fact that forgetting occurs during sleep, even though it occurs less rapidly than when we are awake, is, of course, no basis for discrediting the idea that interpolated activity rather than time itself causes forgetting. Although we are not engaged in learning new activities while asleep, our nervous system is active.

### Relative inactivity

The subjects of the experiments on sleep did not go to sleep immediately, although they tried to do so. It has since been claimed that if it were possible to put the subject "into a dreamless sleep immediately after learning, so that no new experiences would have an opportunity to interfere with, inhibit, or obliterate the old, a perfect retention might be expected."<sup>38</sup> The same writers point out that "Because of the dangers of drugs, anesthetics, and other methods of inducing unconsciousness quickly, no one has thus far attempted to realize these conditions with human S's, but with animals the case is different."<sup>39</sup> The animals used for a test of the activity theory of forgetting were cockroaches. These were selected because they could be rendered inactive without the use of drugs or other agents which might have deleterious effects on the nervous system. The method of rendering them inactive after learning had occurred was extremely simple. They were placed in a state of tonic im-



**11.10 Learning Box.** A correct response involved following a path like that illustrated, rather than entering the shaded area, where a shock was received. (After Minami and Dallenbach.)

mobility or animal hypnosis (p. 178) by inducing them to crawl between layers of tissue paper. Sheets of tissue paper were placed in a box which could be entered through a cone. The inducement to enter was escape from bright light. While in contact with the sheets of tissue paper the cockroach was perfectly motionless. When the period of inactivity was to be terminated, the animal was removed from the tissue paper and tested for retention.

What the cockroach was trained to do was to avoid the shaded area at the end of the box shown in Figure 11.10. Its natural response was to run toward the shaded area at the end of the alleys. But when it ran into this area, the animal received an electric shock through the floor. When it failed to move toward the shaded area, it was pushed. Gradually the cockroach learned to avoid shock by

swerving around the end of the glass partition and returning without entering the shaded area. Each animal was trained until it turned around the partition, instead of entering the shaded area, for nine trials out of ten. Control groups were normally active during rest intervals. The intervals, for different groups, varied from ten minutes to twenty-four hours. Retention was measured in terms of the savings in trials and in the number of shocks administered during relearning.

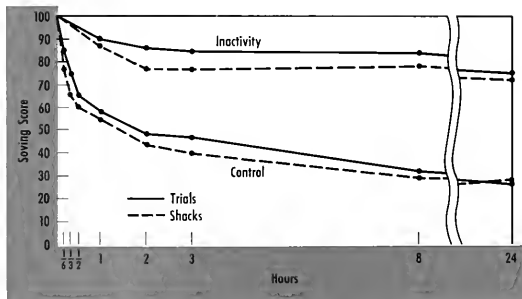
The results of this experiment are summarized in Figure 11.11, which shows the saving score (retention) of the dark-avoidance habit for the inactive and control groups over intervals up to twenty-four hours. It is apparent (1) that the inactive group retained very much more than the active group and (2) that whereas the inactive group showed no further loss of retention between two and eight hours, the active group retained less as further time elapsed.<sup>40</sup>

These results of course favor the view that it is not time *per se* that makes us forget, but what happens in time. Later we will have something to say about the effects of events (such as new learning) which come between original learning and the time of recall. But we first consider the fact that people sometimes forget because they want to do so and sometimes because appropriate stimulation is lacking.

### Repressive forgetting

Like Scarlett O'Hara in *Gone With the Wind*, we may dispose of unpleasant events

**11.11 Active and Inactive Animals — Savings Scores.** This shows the savings in trials to relearn and in shocks administered (for errors) during relearning after each of the indicated intervals. (After Minami and Dallenbach, 38, 2.)





by saying, "I'll think of that tomorrow." When tomorrow comes, with its own events, the unpleasant thought may, as it were, be crowded out. This is *repression*. We discussed earlier (p. 257) the case of a man who, in trying circumstances, forgot his identity. Repression was involved, but the memory defect itself, an example of functional neurosis, is designated *retrograde amnesia*. We read about such functional amnesia quite often in the press.

According to Freud, the mere forgetting of names, of appointments, or of duties to be performed is motivated rather than accidental.<sup>41</sup> Perhaps we accept an invitation to a dinner party and are chagrined, the day after it is over, to learn that we forgot to go. This is inexcusable. It is quite evident to our would-be hostess that we really didn't want to attend her party.

An interesting thing about all such instances of motivated forgetting is that it may be temporary. The memory trace, whatever its nature, is apparently intact. The man with retrograde amnesia, for example, may regain what was lost. The forgetful person recalls the invitation when attention is called to it. Quite evidently, then, forgetting under such circumstances involves some sort of interference with recall, not a loss of the engram. A psychoanalyst, through free-association and dream analysis, may elicit recall of many events which were apparently forgotten. Hypnosis is often conducive to recall of the apparently forgotten, including memories which go back to early childhood.<sup>42</sup> Likewise, under the influence of sodium pentathol (the "truth drug") a patient may recover memories which were previously inaccessible.

Although it is evident that much forgetting is motivated, that interference rather than loss of the memory trace is involved, and that it is possible under certain circumstances to recover the memories which were apparently lost, the basic factors involved are not known. What is of special interest to us here, however, is the fact that forgetting may occur even though the memory trace still exists.

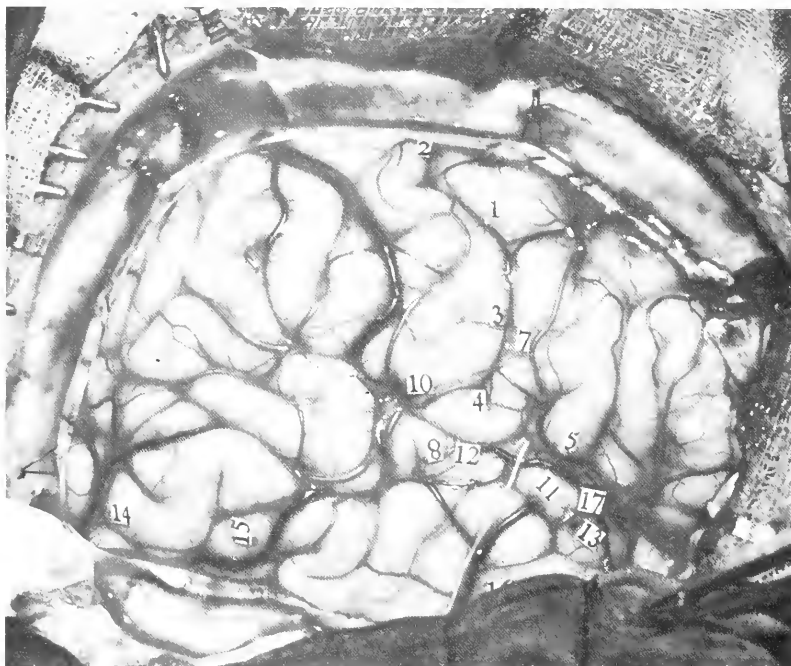
#### The need for stimulation

Some forgetting may occur because the appropriate stimuli for recall are absent. You may be oblivious to some earlier experience.

It may not have been recalled since childhood. Yet, suddenly, you recall it. Upon noting the circumstances, it is apparent that an odor, a name, or some other stimulus is responsible. The effectiveness of free association may be attributed to the fact that it arouses verbal stimuli which, in turn, activate recall of seemingly forgotten events.

A dramatic illustration of how stimuli may arouse memories that were apparently lost is reported by the noted brain surgeon, Wilder Penfield.<sup>43</sup> In the course of operating upon the brain to alleviate certain forms of epileptic seizure, he stimulated various points on the cerebral cortex with a weak electric current. In some regions, as described in Chapter 13, there were reports of visual, auditory, or other experiences — as experiences of the moment, like seeing light flashes, hearing music, and so on. But when Penfield stimulated certain points in the associative temporal cortex, memories rather than immediate experiences were reported. When a certain point (11 in Figure 11.12) was stimulated, one patient said that she heard a mother calling her boy; not now, but years ago. She was told that stimulation would be repeated, but it was not. There was no report. Then the same point was stimulated again. Now there was a further report about the voice calling, and certain details of earlier experience were added, such as the observation that this was taking place in a lumber yard. Stimulated at another point nearby (12 in Figure 11.12) the patient recalled still another childhood experience. Stimulation of a point toward the frontal lobe (point 13) produced memories of voices and also of seeing circus wagons. Still another point (17) elicited memories of an office in which the patient earlier worked as a stenographer and also memories of watching a play. Penfield believes that these incidents would never have been recalled "without the aid of the stimulating electrode."

Such results do not mean that the engram is localized in the bit of brain tissue right under the electrode. Penfield points out that electrical stimulation actually interferes with "local cortical function." However, the local stimulation sets up impulses which, upon being carried to other regions, and perhaps becoming involved in relevant neural circuits, serve indirectly to revive the memories reported. As



**11.12 The Right Cerebral Cortex during Electrical Stimulation.** This is the cortex of a 26-year-old woman. It was exposed during an operation to alleviate epileptic seizures. The numbered tickets mark the points which, when electrically stimulated, produced sensory, motor, or so-called "psychical" responses. The latter include the interpretive illusions and the recalling of previous experiences referred to in the text. (From Penfield, W., *The Excitable Cortex in Conscious Man*. Thomas, 1958, p. 27.)

we said earlier, there is still much speculation about the nature of memory traces and their localization. In this connection, read again the quotation about engrams (p. 310).

Regardless of the nature of the memory trace, it is quite evident that we sometimes forget because the stimuli for recall, for activation of the trace are lacking.

Some forgetting is attributable to a weakening of memory traces, or their obliteration, as an outcome of what happens after learning occurs.

#### **Obliterating memory traces**

Although there is no conclusive evidence that a memory trace deteriorates as a function of time (or disuse), we do know that certain conditions can obliterate it. One of these is the electroconvulsive shock (ECS, for short) used in the treatment of mental patients (pp. 262-263) and also involved in numerous experiments on learning and retention in rats. These clinical observations and experimental studies show conclusively that ECS produces amnesia for the events which immedi-

ately precede it. Patients forget (apparently forever) the preparations just preceding the shock and, in some cases, even the trip into the hospital. Nor do they recall the shock itself.<sup>44</sup> Experiments with rats have shown that ECS administered shortly after each trial greatly retards learning.<sup>45</sup> Given after a habit has been learned, it is followed by poorer retention than in a control group shocked only on the leg.<sup>46</sup> How ECS interferes with retention is not known. Some animal research suggests that it is the convulsion as such that produces this effect, not the passage of an electric current through the brain.<sup>47</sup> It has been claimed that the electric current (or associated conditions, such as temporary anoxia) destroys brain cells. A view more widely held is that a memory trace needs to consolidate, to get set, and the electric current, the convulsion, the anoxia, or some other condition associated with ECS, interferes with this. To quote Woodworth and Schlosberg's *Experimental Psychology*, "anything learned or experienced just before the shock may be irretrievably lost because its traces were not sufficiently established."<sup>48</sup>

An emotional shock may have somewhat comparable effects on retention, presumably because it also interferes with consolidation of the memory trace. This is borne out by general observation of amnesia for events just preceding emotional upset and also by the following experiment:

College students, working one at a time in a small lighted darkroom, were given several repetitions of a list of nonsense syllables, after which they recalled as many syllables as possible. Following this recall they were sometimes given jokes to read, none of which was highly mirth-provoking. They were then asked to recall the syllables again. At other times, and quite unexpectedly, they were given a marked emotional upset after recalling a list of syllables just presented. The back of the chair collapsed, an electric shock was felt in the arms, scrap metal fell from the ceiling to the floor, a pistol shot rang out, and the lights went off, producing total darkness. All of this happened simultaneously. As soon as the commotion ceased, the subject was again asked to recall all of the syllables that he could remember. With the emotion-provoking situation interpolated between first and second recalls, retention was decreased more than under the

control condition. In some individual cases there was a very large decrease. After experiencing the situation described, one subject forgot every syllable in the list.<sup>49</sup>

An important cause of forgetting in everyday life and in laboratory experiments with human subjects is conflict between what has been learned and subsequent learning. One interferes with recall of the other. With respect to retention, there is negative transfer. When the learning of one habit interferes with retention of a subsequent habit, we have an example of forgetting produced by *proactive inhibition*. Of greater overall significance, however, is forgetting caused by interference with retention of the first habit by the learning of a second habit. Interference on this basis is *retroactive inhibition*.

#### Proactive inhibition

Proactive inhibition may be demonstrated by an experiment designed as follows: There are two comparable groups, the experimental and the control. The experimental group learns a list of nonsense syllables (list A) and then another list of nonsense syllables (list B). The control group, on the other hand, learns list B without having first learned list A. It can be demonstrated that the control group learns list B to the criterion more rapidly and with fewer errors than the experimental group. But what of retention, which is of major interest to us here? In a test of retention for list B, the control group is again ahead. The learning of list A by the experimental group not only interferes with the learning of list B but also with retention of it.

The poorer retention of list B by the group that had first learned list A could perhaps be attributed to differences in the associative strength of the list B syllables for the experimental and control groups. It could also be attributed to the intrusion, while recalling list B, of syllables from list A. For instance: list A has the syllables DAX, RIK, etc; list B has the syllables SEK, LAK, etc. In recalling list B, the subject who has already learned list A may erroneously recall DAX or RIK. This is especially possible if the syllables in the two lists have a degree of similarity.<sup>50</sup>

There is a further example of proactive inhibition by intrusion, and one closer to every-

day life. The author is copying a quotation like that on page 311. He looks at the source, then at the paper on which he is writing. As he recalls what he has just read, he occasionally substitutes a word from his own vocabulary for the word that he read. Thus, the printed page says: "The human brain is composed of some 10 billion nerve cells, more or less alike, which interact in various ways. . . ." What he writes is: "The human brain has some 10 billion *neurons*, more or less alike, which interact in *numerous* ways. . . ." It is this kind of proactive inhibition that makes it incumbent upon those who quote others to check, word for word, what has been copied.

A similar process is perhaps involved in falsification such as occurs when we repeat a story with additions, give erroneous testimony, or introduce changes in reproductions of drawings. In each instance, there may be intrusions from earlier experience which interfere with, or supplant, particular features that we are trying to recall or reproduce.

#### Retroactive inhibition

Experiments on retroactive inhibition provide further evidence for the widely held view (p. 327) that much forgetting comes from the effects of activity interpolated between original learning and recall. In a typical experiment on retroactive inhibition, a large group memorizes a list of nonsense syllables (list A). On the basis of this performance, the subjects are separated into two groups with the same mean score. One group (experimental) then learns another list of nonsense syllables (list B). While they are doing this, the control group rests or, to prevent rehearsal of list A, sings, tells stories, or does something else unrelated to learning nonsense syllables. After the experimental group has learned list B, both groups recall as much as they can of list A. The general design of the experiment is thus as follows:

<i>Experimental Group</i>	<i>Control Group</i>
Learns List A	Learns List A
Learns List B	Rests
Recalls List A	Recalls List A

What happens under these circumstances is that the recall score for the experimental

group is usually much lower than that for the control group. This applies rather uniformly to individual scores as well as to group averages. Thus learning list B obviously interferes with retention of list A.

An investigation along these lines with 1,000 school children shows that retention is poorer when other learning is interpolated soon after original learning. The children were separated into equated groups. Some of these studied twenty-five verbs and then recalled all they could after twenty-one minutes and after twenty-four hours. The experimental group studied a list of nouns for seven minutes of the interval. Some of the experimental group studied the nouns immediately after studying the verbs, others studied them following a rest of four minutes, and still others following a rest of eight minutes. Thus, the interpolated learning came at different intervals after learning. The control group sang familiar songs during the entire twenty-one-minute period.

Retention scores (ratios) were as follows: 121 for controls and between 50 and 69 for experimental groups. The lowest retention score within the experimental group was for interpolated study immediately after learning. The longer the rest period between learning and interpolated study, the higher the retention score. Retention after twenty-four hours showed little loss for the control group, but a large loss for the experimental group. Again, the earlier the new learning, the lower the retention score.<sup>51</sup>

Various investigations have shown that there is also a relation between the degree of forgetting and the similarity of the interpolated activity to that involved in original learning. With a very high degree of dissimilarity (as between memorizing words and singing), there is relatively little retroactive inhibition. With a high degree of similarity (as between memorizing nonsense syllables and memorizing other nonsense syllables), there is usually a large degree of retroactive inhibition. Within these extremes the relationship between degree of similarity and degree of retroaction is a complicated one which we need not consider here.

To say that forgetting is due to retroactive inhibition, wholly or in part, does not, of course, explain it. The question, "Why does interpolated learning interfere with retention?" needs to be answered. In all probability, there

are several reasons. One is that learning new material leads to unlearning of the old, especially in the sense that the new responses supplant the old.<sup>52</sup> Another reason, also given to explain why Ebbinghaus forgot more than subjects in comparable experiments (p. 325), is that items learned formerly tend to intrude themselves during tests of retention. Ebbinghaus, it will be recalled, had learned many lists, whereas subjects in the more recent studies learned and relearned only one list. It has been demonstrated, in fact, that subjects recalling a list of nonsense syllables after the interpolation of another list, are often bothered by intrusions from the interpolated material. They give items from the interpolated list in place of the items they are trying to recall.<sup>53</sup> But even when the interpolated items are not overtly recalled, there may be implicit conflict from them which interferes with recall of the initial material. Still another reason often given for poor retention after interpolated learning is that this interferes with perseveration, with reverberating circuits, or, in more general terms, with the setting or consolidation of the original memory trace. The same principle has been invoked (see p. 301) to account for the superiority of distributed over massed learning, and especially the rest periods of the former. This idea cannot be discounted entirely, although there are some difficulties with it, including our ignorance of what memory traces are like, the fact that similar interpolated material is more disturbing than the dissimilar, and the observation that, even after a long interval (during which consolidation of the trace should have occurred), interpolated material still produces interference.<sup>54</sup> It is likely that unlearning, intrusions, and interference with consolidation of the memory trace are all involved to some degree. Early interpolation may interfere with retention primarily because it disturbs the consolidation process. Later interpolation may do so, not by disturbing consolidation, but by causing the individual to unlearn earlier material or to confuse the new material with the old, as in the case of interlist intrusions.

In view of the above, how can we answer the question, "Why do we forget?" One must say that the forgetting of different habits, and forgetting in different situations, may require different explanations. Lapse of time (or disuse of the memory trace) could be respon-

sible for some forgetting, but this has not been demonstrated in a conclusive manner. Improved retention following relative inactivity (including sleep) suggests that activities which occur after learning are more responsible for forgetting than the lapse of time as such. This view is supported by studies showing that the interpolation of new learning tends to weaken retention of the old (retroactive inhibition). Such is especially evident when verbal habits, like recall of lists of nonsense or verbal materials are involved. Some explanations of retroactive inhibition, such as presence of interlist intrusions, could apply only to such habits. It has also been demonstrated that earlier learning may, by interfering with learning of the new, also weaken retention of the latter (proactive inhibition). Most of the habits involved in studies of proactive inhibition are like those on retroactive inhibition and such explanations are likewise of a limited nature. Some forgetting depends upon a poor original impression. Some depends upon the desire to forget and some to absence of relevant stimulation. There is also an obliterating effect upon the memory trace from emotional upset. Electroconvulsive shock is conducive to forgetting, presumably because it obliterates memory traces. Numerous as these reasons are, there are perhaps still other reasons why we forget.

## MEMORY TRAINING

Almost everybody would like to improve his memory. Some want to remember names and faces better. Salesmen would like to remember "selling points" better. Public speakers would like to remember their speeches — or at least remember outlines — so that they could avoid reading them. Students would like to remember better the important points of a lecture or of an assignment. They would like to be able to read lists of French verbs, say, and remember them without a large amount of study. And they would like to have better success in recalling the foreign equivalents of English words, or vice versa. It is not surprising, therefore, that the development of mnemonic systems has a long history and that, even today, thousands of people buy courses whose authors promise improved memory.<sup>55</sup>

Of course all of us use various devices to remember things that are ordinarily difficult

to retain. To quote a writer in the *Scientific American*,

Everyone uses mnemonic devices — ways of memorizing bits of information by associating them with things that are easier to remember. In the U.S. the most familiar of these devices is surely the rhyme beginning: "Thirty days hath September. . . ." Another well-known mnemonic device is: "Every good boy does fine" (for ECBDF, the lines of the musical staff).

The same principle can also be applied, with ingenious variations, to the memorizing of numbers. Such tricks come easily to mathematicians. When Bertrand Russell visited New York in 1951 he told a newspaper columnist that he had no difficulty in recalling the number of his room at the Waldorf-Astoria—1414—because 1.414 is the square root of 2.<sup>56</sup>

Mnemonic courses facilitate remembering, not by developing some hypothetical entity called "memory," as a muscle might be developed by exercise, but by teaching people to utilize various devices which facilitate learning and recall. In the last analysis, whatever success is achieved by those who adopt such devices comes from an increased efficiency of learning or the acquisition of some crutch which facilitates recall.

If you follow principles like those involved in any memory system, you may improve your "memory," but, if such improvement does occur, your "memory" will return to its former efficiency (or should we say, inefficiency?) whenever you fail to use the principles. Sheer memorizing of something, with the idea that it will improve memory as exercise improves a muscle, is a waste of time. This was amply demonstrated in an experiment on college students.<sup>57</sup> One group which memorized various materials "by heart" showed no improvement later in memorizing similar materials. On the other hand, a group which learned to apply efficient principles of learning while memorizing did show an improvement in later memorizing. The improvement came because principles learned while memorizing one set of material were applied to memorizing the other. This is an example of transfer resulting from application of principles. Some of the principles involved in this experiment and a few additional ones are summarized below.

(1) Have the intention to learn. Suppose, for example, that you are introduced to Mr. Flynn. The person introducing him says, "I would like you to meet Mr. Flynn." In all probability you will say, "How do you do," "Pleased to meet you," or something similar. You may not even have listened to the name. You may have listened, but without hearing it correctly. Your poor memory for names may therefore be attributed to failure, in the first place, to learn the name.

(2) If you have the intention to learn, you will also pay close attention to what is before you. If it is important for you to remember Mr. Flynn's name, you will probably listen attentively as the name is spoken.

(3) Use imagery to the fullest possible extent. Try to get a photographic impression of Mr. Flynn which may be revived later. Notice his eyes, his hair, how he is dressed, and so on. If he has a particular accent, that may help you to recall. Some systems advise picturing him doing something ridiculous, the more ridiculous the image the better.

(4) Tie up what you are learning with other things. That is to say, develop as many associations as possible. William James once said:

In mental terms, the more other facts a fact is associated with in the mind, the better possession of it our memory retains. Each of its associates becomes a hook to which it hangs, a means to fish it up by when sunk beneath the surface. Together they form a network of attachments by which it is woven into the entire tissue of our thought. "The secret of a good memory" is thus the secret of forming diverse and multiple associations with every fact we care to retain. But this forming of associations with a fact, what is it but *thinking about* the fact as much as possible? Briefly, then, of two men with the same outward experiences and the same amount of mere native tenacity, the one who *THINKS* over his experiences most, and weaves them into systematic relations with each other, will be the one with the best memory.<sup>58</sup>

Individuals sometimes marvel at how an expert in some field can read a new book in a couple of hours and retain what they could retain only after a course of intensive study. The reason for the expert's "better memory" is, of course, his background in the field. He

has, as it were, many hooks on which to hang what he reads. The newcomer to the field must "start from scratch."

Most memory "systems" give major emphasis to association. Some of these advise one to memorize a list of logically related words. First this list is mastered thoroughly, so that it can be said forward and backward, and the word in any position (sixth, forty-first, and so on) can be recalled without hesitation. Then each new thing to be remembered is, as it were, "hooked" onto one of these words or placed in the appropriate "file." If a list of "selling points" is to be memorized, for example, the first is associated with the first word in the list and the second with the second word, and so on. The first words, being so thoroughly retained, are recalled quite readily. In being recalled, they tend to bring the respective "selling point" with them.

In stressing association, most memory systems utilize the idea of getting vivid, even ridiculous associations in addition to those provided by the system itself.<sup>59</sup>

## Summary

Remembering in the most general sense is retaining. It is mediated by neural modifications, referred to as memory traces or engrams.

Before language develops, memory is evidenced by: reproduction of a motor performance; relearning a habit with a saving in trials, errors, or time; and delayed reaction. Ability to do delayed reactions indicates the presence of recall memory, an elementary symbolic process. It is symbolic because an engram of some kind represents (is a symbol for) what is recalled. The interval between removal of a critical stimulus and successful recall increases as we ascend the animal scale. It also increases in the individual from infancy to maturity. Bridging the time interval is greatly facilitated when verbal symbols are acquired.

Verbal recall is studied in a variety of ways. Special attention has been given to the memory span, the memorizing of item lists by various procedures, recall of narratives, reproduction of forms, testimony, and eidetic imagery. All of these involve recall and, with respect to some of them (narratives, testimony), we noted errors which have significance in such

(5) Rhythm is an aid to retention. This has been shown in several laboratory researches and it is exemplified in the theme songs of radio advertising, and in rhymes such as "—'s taste good like a cigarette should." The writer learned the multiplication table in a sort of sing-song and this no doubt helped it stick. There are decided limits, however, to the application of rhythm in learning.

(6) Distribute your learning as much as possible. If you can avoid it, do not cram. You may "get by" the next day, but the chances are that you will not retain very much over longer periods.

(7) Where possible, rehearse or recite. We have already pointed out the advantages of recitation compared with passive reading.

(8) Rest, or, better still, sleep after you have studied. From what we know about the obliterating effect of interpolated activities, it is poor practice to study one subject immediately after getting through with the study of another. There should at least be a pause in which anything like study is avoided.

aspects of everyday life as transmission of rumors and inaccurate testimony. In recall of narratives, pictures, and events, the theme is usually retained, but the details change, some being omitted and others added. When eidetic imagery is present, recall may be unusually accurate, much as in so-called "photographic memory."

Any fraction of some former stimulating situation may be sufficient to elicit recall of the whole situation. This is response in terms of reduced cues. Another name for it is redintegration.

In recognizing, we differentiate the familiar from the unfamiliar. This is easier than recall. False recognition shows the influence of reduced cues.

Procedures which facilitate learning are also conducive to good retention. Distributed learning and recitation exemplify this principle. Although overlearning aids retention, there are diminishing returns from large amounts of it.

Under ordinary circumstances, fast learners retain more than slow learners. This is because they learn more in the same learning period

and because they also overlearn. But when the associative strength of what is learned is held constant, fast and slow learners retain equally well.

Forgetting, in an ultimate sense, is failing to retain—a loss of the memory trace. On the other hand, forgetting may occur even though the memory trace remains. This is evident in repressive forgetting, an extreme form of which is functional retrograde amnesia. Forgetting sometimes occurs because stimulation adequate to activate the memory trace is absent. Recall of what has apparently been forgotten may be facilitated by hypnosis, use of sodium pentathol, and direct electrical stimulation of certain regions in the temporal cortex. Some “forgetting” may also be attributed to absence of a memory trace (or a poor one) as in anterograde amnesia.

Experimental studies show that forgetting is at first rapid, then relatively slow. Although there may be some deterioration of the memory trace with time (with disuse), this has not been demonstrated conclusively. There is much evidence, on the other hand, that forgetting is produced, not by time *per se*, but by what happens in time. For example: the least amount of forgetting occurs after inactivity and sleep; the greatest amount, after interpolation of activities between original learn-

ing and tests of retention. The latter effect (retroactive inhibition) is greatest when the new learning comes soon after the original and when it involves similar, but of course not identical, material. Earlier learning may also interfere with learning and recall of what is learned later, the phenomenon of proactive inhibition. In retroactive and proactive inhibition we have further examples of negative transfer effects. These effects are sometimes rather obviously due to the intrusion, into what is being recalled, of items learned earlier. Sometimes there may be conflict without actual intrusion. With respect to retroactive inhibition, there is also the possibility that interpolated learning interferes with perseveration and consolidation of the memory trace. Moreover, in learning interpolated material, a subject may, to some extent, unlearn the old. There is at present no reason for concluding that any one of these factors operates to the exclusion of the others.

Memory training is successful to the degree that it increases the efficiency of learning—it does not develop a “memory” faculty. Using the principles involved—intending to learn, getting imagery, associating, and so on—will improve one’s “memory” but, whenever he fails to apply them, his “memory” will be no better than it was before.

(References and notes for this chapter are on page 561 of the Appendix.)

## Selected Readings

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# Thinking

12



Evidence for reasoning · Thinking machines · The reasoning process · Language and thought · Is thinking necessarily motor? · Concepts · Experiments on concept formation · Creative thinking · Summary

From learning to retention and then to thinking is a logical transition, for what we think with must be learned and retained. We think with symbols. These, as we saw in the discussion of delayed reactions, represent past experience. They may be words, gestures, or images. We may think of some object, person, or event in terms of our word for it, a gesture which represents it, an image of it, or less evident substitutes, like muscle tensions which have come to have meaning in terms of past experience. Kinesthetic imagery has often been suggested as an aspect of the thought processes. Who has not seemed to be on the verge of recalling something, yet without any word or clear image of what he seeks? The vague inner tension which appears to exist under such circumstances may well be kinesthetic. But engrams may also serve a symbolic function without being externalized in verbal or gestural expressions and without the arousal of images.

We think with what we retain from past learning; but we also, through our thought processes, learn things that we did not know before. The inventor puts together bits of information relevant to the problem before him and he comes up with something new. The atomic scientists, following the same general procedure, could predict the atomic explosion before it had ever occurred. Thinking about what was already known to them taught them something not known before. The fact that we may learn by thinking has led psychologists to refer to thought as a "higher learning process."

Thinking is typically a sequential arousal of symbols. We think of one thing; that

starts us thinking of another; that of still another, and so on. In this way we manipulate and rearrange, as it were, the various aspects of the world which have fallen within the range of our experience. Except when we "think out loud," this process is carried on implicitly. Words are unspoken and the gestures are so abbreviated as to escape notice. The images and other processes are by their very nature implicit.

In this chapter our chief concern is with the kind of thinking called *reasoning*. Reasoning is differentiated from mere *thinking* of something, because it involves a sequence of symbolic activities. When you *think* of something, you are of course calling up symbols which, like those aroused in the delayed reaction experiments, enable you to respond in terms of absent stimuli. This aspect of the thought processes is synonymous with *recall*.

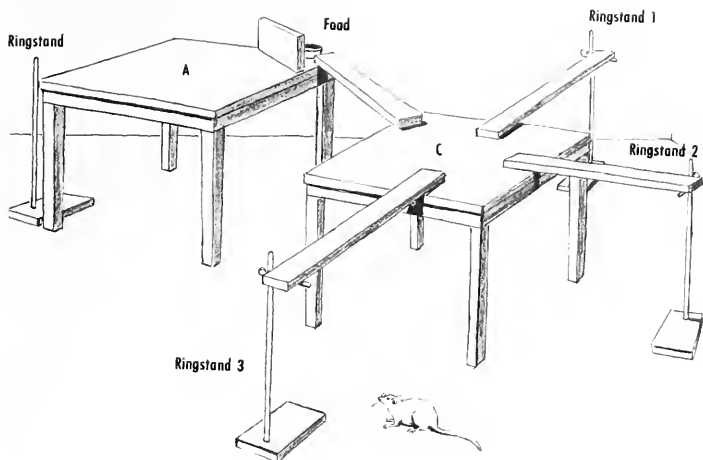
Reasoning also differs from what has been called *reverie*, or free association of ideas. This is because, in reasoning, what we recall and the sequence of associations involved are controlled. In reverie, the associations are random, as they would most likely be if I should ask you to say every word which comes to mind. In reasoning, however, the "associations begin in a problem, and end in its solution."<sup>1</sup> The nature of the problem gives us a directional *set*. It produces selective rather than indiscriminate recall. Suppose instead of asking you to say every word which comes to mind, I should ask you to say the names of animals. Then you would have an "animal set." Your associations would concern animals, and nothing else. In reasoning, the set comes from the problem. If the problem is how to get our car started, we think of things that might be wrong with the car, not of unrelated things.

Reasoning is differentiated from the type of thinking called *fantasy* by being more realistic than the latter. Typical forms of fantasy are dreaming and daydreaming (pp. 217-219). Dreaming, as we have seen, is often directed toward the solution of a problem — but the solution is usually unrealistic. Sometimes the dream is a symbolic wish-fulfillment, as claimed by Freud. You would, let us say, like to spend a winter in Florida. In the dream you buy your ticket, get on the train, see the landscape passing by, alight at a fashionable seaside resort, and so on, even though there is, in reality, no chance of your being able to make the trip. The dream fulfills your wish, but only symbolically.

Sometimes the dream fantasy looks like an attempt to explain some sort of present stimulation. You dream, for example, that you are hanging by your hands from a sky-craper, you see the street way below with its toy-sized people and vehicles, your fingers are slipping, and you scream for help, perhaps waking yourself. Then you find that you are lying on your back with your arms stretched back in an awkward position, caught under the end of the bed. You are actually in a predicament, but not the predicament symbolically represented. The writer dreamt that he was trying to escape from hell, but woke to find his feet on a hot radiator. The dream fantasy often, so to speak, seeks a way out of difficulties.

Daydreams are essentially like dreams. The fantasy is again unrealistic. If you are not able to meet your financial obligations, for example, you may imagine yourself winning thousands of dollars in a contest, digging up buried treasure in your garden, or receiving a legacy from some rich uncle. You may, on the other hand, lay definite plans to solve your problem. You may think of getting a job that pays a larger salary, of selling some of your property, or of doing some extra work in spare hours. If these are realistic solutions — solutions probable of accomplishment — we say that you have been reasoning, rather than that you have been daydreaming.

Reasoning appears in lower mammals like the rat and it becomes increasingly evident and complex as the human level is approached; at the human level it begins in early childhood.



**12.1 A Reasoning Test for Rats.** A rat is first allowed to explore the room, the ringstand, and table A, reached by climbing the ringstand. The partition around the food blocks off this region. Preliminary exploration continues for a few days so that familiarity with every aspect of the situation may develop. Table C is then added and an elevated pathway is run from it to the food. Three other paths each reached by a ringstand are connected with C as illustrated. Any one of these ringstands and pathways leads, via C, to the food. Learning to run from any part of the room, up a ringstand and onto table A is Experience I. It does not enable the rat to reach the place where food will appear in the actual reasoning test. After addition of C and the new ringstands and paths, the animal is trained to climb one of the three ringstands and traverse the path which runs from it to C, and from C to the food. This is Experience II. The test of reasoning comes when the rat is placed at A. Its problem is to reach the food. It has learned to descend a ringstand (part of Experience I), and it has learned to climb, let us say, ringstand 3 and proceed from that point to C, and then to the food (Experience II). But it has never before descended the original ringstand and gone to ringstand 3. Will the rat bridge this gap? If it does so without further training, one may conclude that it has combined the two separate experiences. (After Maier, 2, 23.)

### EVIDENCE FOR REASONING

Some ancient writers referred to man as "the reasoning animal" and at the same time implied that other organisms do not reason. We now know that man is not the only reasoning animal. Reasoning is evident in lower mammals like the rat. But how do we know? What is the evidence? Our discussion of the evidence will serve three purposes: (1) tell how we know that animals

can reason, (2) demonstrate how the same problems may be used to compare animal and human reasoning, and (3) indicate something of the nature of reasoning itself — especially in its elementary stages.

Looked at from one standpoint, reasoning is combining past experiences in order to solve a problem which cannot be solved by mere reproduction of earlier solutions. Rats, as we know, are adept at learning mazes. They ac-

quire a series of responses which leads them to the food; or, as some would say, they learn where the food is. In any event, there is no evidence here of reasoning. It is conceivable that the rat is responding directly to stimuli without the mediation of symbolic activity. Suppose, however, that we teach the animal two different habits as illustrated and explained in Figure 12.1, then confront it with a new problem—one that can be solved only if both habits are combined. If an untutored solution is achieved, if the problem is solved more or less suddenly by “putting two and two together,” we must credit the animal with at least a modicum of reasoning ability.

In a variety of tests like that illustrated, rats have indeed shown that they can put two and two together. They first learn how to get onto or off one table (by climbing or sliding down a ringstand). They learn to obtain food by climbing a ringstand to another table and running along the proper pathway. But they have never descended from the first table, run across the floor, and climbed the ringstand to the second table. In the crucial test, in which this is the only way to reach the food, some rats solve the problem. After a certain amount of random activity on the first table, they slide down the ringstand, run across the floor to the other ringstand, climb it, and run to the food. The ringstand climbed is the one involved in the particular animal's earlier training.<sup>2</sup>

This behavior resembles the insightful problem-solving which we discussed earlier (p. 288) with respect to learning of detours and puzzle boxes.

Reasoning at a greater level of difficulty than that just described calls for discovery of a principle. An animal cannot, of course, tell us the principle. Nonetheless, we can observe from behavior whether or not the principle has been discovered.

Two problems have revealed this sort of reasoning in animals and both have been extended to human subjects. One calls for multiple choice, the other, for double alternation.

#### Multiple choice

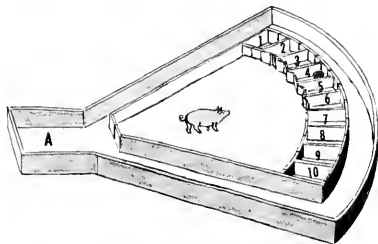
In solving this type of problem, an animal

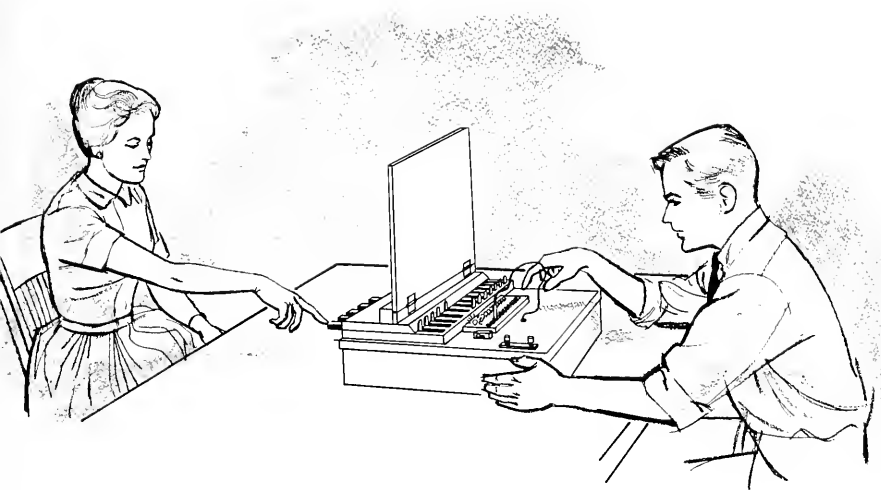
must learn that the aspect associated with a reward always bears a certain relation to other aspects. Thus a subject given the problem represented in Figure 12.2 may be required to learn that the *middle* door in each setting is the correct one.

The doors vary in number and position from trial to trial, but the middle one always provides a reward. The middle-door and other multiple-choice problems have been solved by various organisms ranging from birds to human beings.<sup>3</sup>

A multiple-choice apparatus for human subjects is shown in Figure 12.3. The procedure here, as described in the legend, is an adaptation of that used with animals. However, the problems which animals solve are too easy for normal human adults. We therefore require the latter to discover a relatively difficult principle. One example is the problem calling for an alternate response to keys on each side of the central key—that is, *right of center, left of center, right of center*, and so on, with a different number of keys (variously placed) from one setting to the next. This principle is difficult even for college students. They sometimes require many trials before discovering the correct solution, which, moreover, is usually verbalized.

**12.2 Yerkes Multiple-Choice Problem.** Here doors 2–6 are open and the middle one, door 4, is boited. The other compartments must contain the odor, but not the food, otherwise response to the correct door might be made in terms of odor alone. Some investigators have food at the entrance, rather than in the compartment. Then the animal, after leaving the correct compartment, is allowed to return to A, where he gets a bite of food. This apparatus has been used with rats, monkeys, chimpanzees, and other animals besides the pig. (After Harlow.)





**12.3 A Multiple-Choice Apparatus for Use with Human Subjects.** Certain keys are pushed toward the subject and she presses the key which she believes to be correct. If the key is correct, a buzzer sounds. Pressure on the incorrect key lights a bulb in a corresponding position behind the screen (as illustrated), thus telling the experimenter which key has been selected. The subject continues to press keys until the buzzer sounds. Then a new setting is presented. Settings are presented until the subject reacts without error to a predetermined series, or, as usually happens, states the principle. In this case the middle key is correct. (After R. M. Yerkes.)

#### Double alternation

An open alley *temporal maze* is often used to study the reasoning process in animal and human subjects. Older children and adults may also be tested with a stylus maze like the apparatus illustrated in Figure 12.4. But, whichever version of the temporal maze we use, the problem is essentially similar, i.e., to make a temporarily related series of responses. This series is usually *right, right, left, left (rlll)* or the reverse.

After walking (or tracing) the central alley, the subject is required to turn right the first time, right next, then left, and finally left again. Four trips constitute one trial. A rest follows. Each correct turn brings a reward, although in the case of adults this is perhaps

no more than the knowledge that a correct response has been made. Each incorrect turn may bring an electric shock or, in the case of human subjects, a buzzer or some other signal that an error has been made. After a wrong turn, the subject must retrace until the correct alley is reached.

Observe that the apparatus is bilaterally symmetrical, and that there are no external differential cues to guide the subject. If a dim light flashed on whenever a right turn was to be made and a bright light whenever a left turn was required, these lights would serve as differential cues. We would have a mere discrimination problem. The correct turn would be made in terms of the brightness of the light at the end of the central alley.

Suppose that no lights were present, but

that the right and left turns were made in different places within the apparatus. Then we would have the type of maze considered in Chapter 10. This is sometimes called a *spatial maze*, because the turns differ in space. Differing in space, they provide different visual, auditory, olfactory, tactual, and kinesthetic cues to which the respective turns may become conditioned. Making the correct turns in this type of maze, whatever their sequence, would provide no proof of reasoning. In the *temporal maze* used in reasoning tests, however, each turn occurs in the same place, at the end of the central alley. In short, a temporal rather than a spatial sequence is learned. Moreover, all external conditions are identical, regardless of whether the turn required at any moment is right or left.

But how about kinesthetic cues; those associated with muscle tensions? One might think that these would provide cues for the required turn. If the sequence were *rlrl* instead of *rlll*, this might be true. Having turned to the right in one trial might produce muscle tensions which would persist until the animal reached the same point again. These cues might become conditioned to a left turn. Likewise, muscle tensions persisting after the left turn might serve as conditioned stimuli for a right turn. But in the *rlll* sequence, no such guidance is possible. After having turned right the first time, the animal might have muscle tensions which would guide it to the right again. On the third trip, however, the same muscle tensions would have to guide the animal to the left. Muscle tensions from just having gone to the left would then have to guide to the left again. In a continuation of the sequence, the same tensions would have to guide the animal to the right. In other words, the same muscle tensions would at some stages have to guide the animal in one direction and at other stages in another direction. Such a dual guidance by the same stimuli in close temporal succession is impossible. The only satisfactory explanation of *rlll* responses in the temporal maze is that the animal somehow "figures out" the proper sequence.<sup>4</sup>

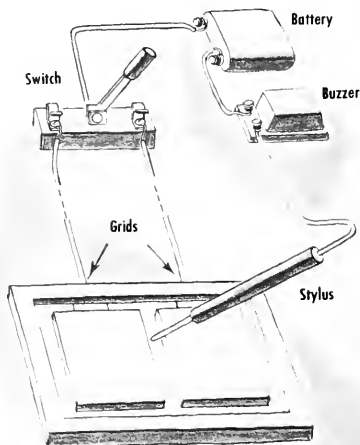
Human subjects usually formulate this problem verbally. They attack it in an overt trial-and-error fashion at first, but soon begin to test out this or that hypothesis. The

correct hypothesis is sometimes hit upon rather suddenly. A subject may seem to be making no progress — then a correct sequence occurs. Following this he says something like "Oh, I get it. You go two times to the right and two times to the left." He often reports that he tried out and tested various other hypotheses before hitting upon the correct one.

White rats, the lowest animals tested with the temporal maze, have not learned the problem in its usual form, even in one thousand trials. But some have learned the solution by other means. They first learned the separate turns in different T-shaped boxes. Then the *rr* sequence was taught in one box and the *ll* sequence in another. Transferred to the temporal maze after such training, a few of the rats eventually learned the *rlll* sequence. When required to continue after the *rlll* series, they responded *lilll*. . . . Rats thus failed to continue the sequence.<sup>5</sup>

Raccoons, on the other hand, have learned the sequence in the temporal maze directly — that is, without preliminary training in other mazes — and have continued the sequence

**12.4 A Stylus Form of Hunter's Double-Alternation Temporal Maze.** The stylus is shown in the central alley near the choice point. As he moves toward the bifurcation at the top, the subject must decide whether to go to the right or the left. The buzzer sounds whenever he makes the wrong move. For further explanation, see the text.



for two additional turns, making the response series *rrllrrrr*. This shows a much better grasp of the problem than occurs in rats. Monkeys have done better still. In a special form of the problem, they have learned an *rrllrrll* sequence, then extended the series to eight additional turns, their total series of responses being *rrllrrllrrllrrll*.<sup>9</sup>

Children who are three years or younger have not been able to solve the double-alternation problem. Other children and adults have solved it much more readily than animals and they have also extended the series until told to stop. When asked to continue, that is, they have usually responded *rrllrrllrrllrrll . . .*, perhaps saying "right, right, left, left . . .", either overtly or implicitly, while doing so.

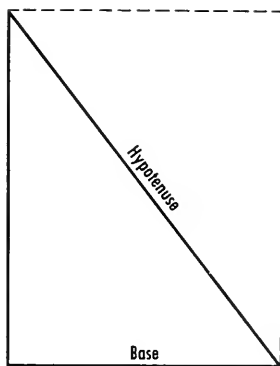
Normal adults learn double-alternation problems much more readily than children. In one study, the average number of errors per subject for children was 30 as compared with 16 for adults.<sup>7</sup>

In addition to showing that animals as well as men can reason, the studies we have reviewed indicate that reasoning is not necessarily verbal. However, three things are essential. In order to reason, an organism must (1) retain aspects of earlier experience, (2) recall these when occasion arises, and (3) combine them in such a manner as to solve problematic situations. Most animals can retain, but mammals alone have shown evidence of recall—as in the delayed reaction test (pp. 312–314). We have seen that mammals from rats to men may, upon occasion, achieve the higher level, reasoning.

### THINKING MACHINES

It is interesting to observe that the "electronic brains" or "thinking machines" about which we hear so much today have functions corresponding with the above built into them. There are memory devices (punched cards, magnetic tapes, or electronic tubes) which, in coded form, store information fed into the machine. Then there are devices for giving the machine access to the "memories" relevant to a problem and for collating these in such a manner as to provide a solution.<sup>8</sup>

Apart from the fact that "reasoning" done by "thinking machines" is merely computational,



### 12.5 Finding the Area of a Right-Angled Triangle.

It is possible to find the area of any right-angled triangle, with only the base and hypotenuse given, by following the algebraic steps: 1)  $h + b = v$ , 2)  $h - b = w$ , 3)  $v \times w = x$ , 4)  $\sqrt{x} = \pm y$ , 5)  $y \times b = z$ , 6)  $z \div 2 = \text{area}$ . On the other hand, as Wertheimer pointed out in his *Productive Thinking*, there is a way to teach this problem which gives more insight. Observing that the triangle is one half of a rectangle of the same height and base, the learner can solve this problem more simply, and with greater understanding and transfer value, by finding the altitude with the Pythagorean theorem (the square on the hypotenuse equals the sum of the squares of the other sides), the area of the rectangle from the base and altitude, and the area of the triangle by halving this. (After Miller, G. A., "Information and Memory," *Scientific American*, August 1956, 42.)

there are other major differences between the most complex of these and a thinking organism. One is illustrated in finding the area of a right-angled triangle. As shown in Figure 12.5, we may consider the area of such a triangle as one half that of a rectangle, the area of which is the base times the height of the triangle. A child who is taught this may transfer the solution to similar triangles in different dimensions. A "thinking machine" could answer the same problem, and do so rapidly, when given it in suitable form. But the process would be routine to the  $n^{\text{th}}$  degree.

Before a computer could begin to calculate

anything, even the area of a right-angled triangle, the procedure to be followed would need to be programmed, step by step, somewhat as in the legend. To quote George A. Miller, whose example we have borrowed:

The machine is able to perform arithmetical operations such as addition, subtraction, multiplication, division and the extraction of roots. Instruction for the machine consists in writing a "program"—like the series of steps [in the figure] except that the computer's program must be even more explicit and detailed, with even less hint of the basic strategy. Computing machine engineers have their hearts set on some day designing machines which will construct programs for themselves: that is, given the strategy for handling a problem, the machine will understand the problem well enough to create all the appropriate operations or subroutines required to solve it. The desirability of such a development is obvious. In the first place, at present it takes many hours of drudgery to write the detailed instructions for all the steps a computer must take. Then, after the instructions have been written, they must be stored in the machine in some easily accessible form. In a large machine the number of subroutines may run into thousands; it might actually be more economical to equip the machine with the ability to create them on demand rather than to build the necessary storage and access machinery. In other words, in a very elaborate computer it would be more efficient to store rules from which subroutines could be generated than to store the routines themselves.<sup>9</sup>

One would not give as simple a problem as that illustrated to a computing machine. It is much more easily solved with one's own brain. However, enough has been said to emphasize the fact that, despite current interest in "electronic brains" or "thinking machines," none has yet even approached the versatility of a human brain.

There is obviously much more to thinking than one finds in a rat solving elementary reasoning problems, a monkey discovering a principle, or an "electronic computer" finding the answer to a complex mathematical problem. Some of the differences between the thinking of rats, monkeys, and machines be-

comes increasingly evident as human reasoning is discussed.

## THE REASONING PROCESS

Reasoning does not occur unless there is a difficulty, or unless a question has arisen for which there is no ready answer. It is quite possible that the rats and other animals used in our experiments on reasoning reasoned then for the first time in their lives. It is quite possible, too, that they never again reasoned after psychologists finished the experiment. In order to induce these organisms to reason, it was necessary to confront them with problems which could not be solved by mere reproduction of former solutions, by conditioning, or by overt trial-and-error.

In man, also, reasoning is only initiated by situations which cannot be met in a routine manner. We may go for hours or even days without reasoning, especially if our work is so routine that habitual modes of response enable us to meet, in a more or less automatic manner, every situation that arises. As soon as habitual modes of response fail, however, reasoning is likely to begin. Some problems of everyday life which initiate reasoning are how to get certain things done, how to make something go that has stopped, how to get food, how to pay our bills, how to get where we want to go, and how to avoid distressing situations. Being human, we also express curiosity about aspects of the world. We want to know what certain things are for, and why certain events occur. An average child of three years is already puzzled by objects, situations, and events not directly related to its personal adjustments.

In their investigations of human reasoning, psychologists have, for the most part, used relatively artificial situations in which verbal, numerical, or graphic symbols predominate. Sir Frederic Bartlett, who regards thinking as "a high-level form of skilled behavior, requiring signs and symbols for its expression," has drawn attention to what he calls "thinking within closed systems."<sup>10</sup> Here certain information, or evidence, is given and the thinker's task is to "fill up gaps in the evidence." The following is an example:

*A, By*

*Horrible*

Given these three scraps of information, the



subject is asked to fill the gap. Some fill it in any old way. Some indulge in flights of fancy. But the serious thinker looks for a logical scheme, one that makes some sort of sense. So he may interpolate the words:

*Can, Door, Every, Floods, Gunners*

His solution, therefore, is: each word must be longer, by one letter, than the preceding, and begin with the next letter of the alphabet.

Some problems call for extrapolation. The information given might be:

A, GATE, NO, I, DUTY, IN, CAT, BO, EAR,  
O, TRAVEL, ERASE, BOTH, GET, HO,  
FATE

ERASE  
FATE

The subject is told: "from the group of words above, complete the vertical arrangement indicated by the two words 'erase' and 'fate,' taking 'erase' as the middle word in the column. Not all the words given need be used." Confronted with this problem, individuals adopt various strategies. A few, observing that "fate" has one letter less than "erase," that "duty" also has one letter less, and so on, achieve the following solution:

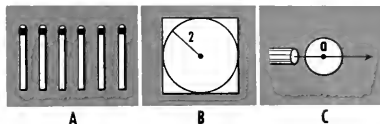
A  
BO  
CAT  
DUTY  
ERASE  
FATE  
GET  
HO  
I

More information from which to extrapolate may be given — for example,

DUTY  
ERASE  
FATE

When this is done, the solution given above is, of course, much more readily obtained.

Other reasoning problems used by Sir Frederic Bartlett involve what he calls "adventurous thinking," thinking with a larger element of freedom than in the examples cited.<sup>11</sup> The thinking of scientists, artists, and novelists falls in this general area.



**12.6 Some Reasoning Problems.** A. Problem: to make four equilateral triangles. B. Problem: to find the area of the square. C. Given: an inoperable stomach tumor situated at **a**, and rays which destroy organic tissue at sufficient intensity. Problem: how to destroy the tumor with these rays, yet without injuring the surrounding healthy tissues. For answers, see p. 492. (After Duncker.)

Three reasoning problems which come closer to situations of everyday life than those described above are shown in Figure 12.6. Solve them, noting at the same time, if you can, how the solution was achieved. Then check your answers by referring to the Appendix. Some of these problems enter the ensuing discussions of the reasoning process.

### Inferences

You will doubtless have noticed that, once the problem was given, and you accepted the task of solving it, suggestions began to occur to you. These are known as *inferences* or *hypotheses*. Quite often they occur as questions. You say, "Must the whole match be used for the side of a triangle?" "Will it work if I cross the matches?" And so on.

Let us illustrate from a problem of everyday life. Suppose that your car stops all of a sudden without apparent cause. You ask, "What's the matter?" "Could it be that I have run out of gas?" You may check the truth of the inference that you have run out of gas by looking at your gas indicator or, if you don't trust that, by examining the gas tank. These are what we might call *explicit* methods of testing your inference, but you might test it *implicitly* by recalling that you filled the tank only yesterday, that you have traveled so many miles since then, and that it could or could not be empty — unless the gas tank has sprung a leak or someone has syphoned off some gasoline. Failing to find the tank empty, you get another suggestion

or make another inference. "Is the gas line choked?" You then check that possibility. So one inference after another occurs to you until, providing you do not run out of relevant inferences beforehand, one of them is found correct. If your knowledge of automobile motors is limited, you may run out of inferences very soon. You must then call in an expert, one who has many more symbolic representations of motors and things that might go wrong with them than you have.

Inferences involve recall of past experience. They are always limited by what one already knows about the situation involved. The more facts he can recall about the situation, the more inferences he is likely to make and the better these inferences are likely to be.

Those who claim that education should teach people to think rather than cram facts into their heads often overlook the dependence of thinking upon facts with which to think. We should be taught facts, especially those that are relevant to situations which we are likely to meet, and we should also be taught to think more efficiently.

Inferences are usually evaluated before being accepted or rejected. Dewey calls this the *rational elaboration of ideas*. We may accept the first inference that comes to us or we may bring relevant knowledge to bear upon it. Evaluating an inference in the light of other knowledge at our disposal sometimes leads to rejection, than to making a further inference. Thus, we realize that, in terms of how much gas we had in our tank yesterday and the number of miles we have traveled, our gas could not have been used up. Then we think of other possibilities.

Sometimes an objective test of our inferences is necessary. Our critical evaluation of an inference, like that of the empty gas tank, for example, may convince us of its correctness. In many instances, however, and especially in scientific reasoning, it is necessary to prove the correctness of an inference by objective or experimental means. It often happens that inferences generally accepted as reasonable are found to be false when tested experimentally.

#### Direction

Recall in reasoning is, as we have already

seen, directed rather than random. The nature of the problem, as one conceives it, gives a more or less definite trend to what is recalled. If our car has stopped running, we recall things about cars. Our inferences concern cars and what we know can happen to cars. We are not likely to recall things that are completely irrelevant. The inferences that we make are related more or less closely to the problem as we conceive it.

It often happens, however, that our inferences, while generally bearing on the problem, follow an inadequate direction in other respects. There are many examples of this in everyday life. A man in his early forties, say, begins to have dizzy spells and jumps to the conclusion that his heart has gone bad. He begins to think of cleaning up his affairs in case he should drop dead. He limits his exercise and his eating. Finally, he convinces himself, or someone else convinces him, that he should have a physical examination. The doctor finds nothing wrong with his heart, but asks some questions about his eyes. Then the patient recalls for the first time that he finds it easier to read if he holds the paper at arm's length, that he experiences difficulty in reading small print on labels, and that his dizziness comes when he suddenly looks from a near to a more distant object, or vice versa. None of these things occurred to him before because the idea that there must be something wrong with his heart sent him thinking in the wrong direction. A checkup with the oculist shows that the patient needs bifocals in place of his present glasses. He makes the substitution and his dizziness eventually disappears.

*Delusions and directions.* Certain delusions of the mentally ill are attributable to reasoning in wrong directions. In so-called "monomaniacs," for example, the direction of associative processes gives bizarre interpretations to the most innocent events.

Has she a tired look? — it is proof of adultery; a gay manner? — she comes from a rendezvous. A look, a movement of the eyebrows, lips, or fingers are so many telltale signs; the same with smiles or tears. Should she utter the name of the supposed lover, the sound of her voice leaves no doubt; should she repeat it often, it is to "accustom herself

to hear it in public without blushing"; if she ceases to mention him, the motive can be guessed. In the street, the jealous man thinks that the passers-by are laughing at him; ceaseless allusions are made to his misfortune; he is taken for a complaisant husband. His wife's footsteps on the parquet floor are so many signals to her lovers and compose a telegraphic alphabet that he can successfully interpret. . . .

Mme. X . . . studies minutely the letters that she receives. Punctuation marks or spelling mistakes give rise to numerous interpretations. Her father writes to her: "We desire your cure." She observes that the stop is of an unusual size; it must read: "We desire your cure to stop." (*Nous ne désirons point ta guérison.*) Another woman imagines that her husband is announcing the intention of leaving her by putting two five-centime stamps on a letter instead of a ten-centime one. A look, a smile, a gesture, the shouts and songs of children, the coughing or spitting of a neighbor, the whispers of passers-by, pieces of paper found in the street, a door opened or closed, a mere nothing, serves as a pretext.<sup>12</sup>

*Direction in problem-solving.* The disadvantage of getting the wrong direction and the advantage of getting the right direction in problem-solving has been investigated in the laboratory. How the wrong direction or wrong set may interfere with solution is illustrated by the problem indicated in Figure 12.7. One is required to connect the nine dots by drawing four straight lines without taking the pencil off the paper and without retracing.

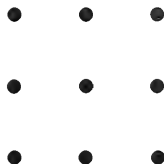
In attempting to solve this problem, you make one inference after another, and all are relevant in that they concern the nine dots and the instructions. Any inference which concerns the nine dots, but fails to conform with the instructions, is rejected almost as soon as suggested. You have a set, in other words, that is related to the dots and to the instructions. But you may also have a set not involved in the instructions—that is the set which makes you keep all lines within the limits of the area bordered by the dots. As long as your thinking follows this direction, you cannot solve the problem. Every infer-

ence will prove inadequate. But when you think of the possibility that lines may go outside of the area within the dots, you have the right direction. The solution may still be far off, but at least you will make inferences more in keeping with the requirements of solution. Eventually, you may hit upon the solution illustrated on page 492.

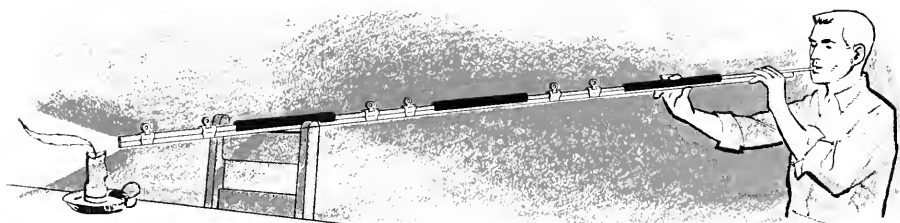
Following a certain line of thought to the exclusion of others, as in the above example, often seriously interferes with problem solution. The importance of shifting direction is illustrated by an experiment with college students.

One of the problems used in this study called for blowing out a lighted candle from a distance of eight feet with nothing but the materials illustrated in the lower part of Figure 12.8. A group consisting of 206 students worked without any suggestion from the experimenter that they should vary their mode of attack. Forty-eight per cent of this group solved the problem within the time allowed. Another group consisting of 178 students was given a preliminary lecture covering twenty minutes in which the following advice was given and elaborated:

1. Locate a difficulty and try to overcome it. If you fail, get it completely out of your mind and seek an entirely different difficulty.
2. Do not be a creature of habit and stay in a rut. Keep your mind open for new meanings.
3. The solution-pattern appears suddenly. You cannot force it. Keep your mind open for

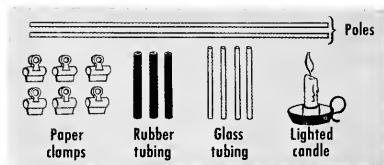


**12.7 The Nine-Dot Problem.** Connect these dots by drawing four straight lines without taking the pencil from the paper and without retracing. The solution is on page 492.



## 12.8 Maier's Candle-Blowing Problem.

Problem: Given the above poles, clamps, and tubes, blow out the candle from a distance of eight feet.



new combinations and do not waste time on unsuccessful efforts.

The problem was solved within the time limit by 68 per cent of this group — 20 per cent more than in the group that received no instructions about changing direction.

In a check experiment, 169 subjects attacked two problems of equal difficulty, one before and one after receiving the above instructions. Here the effect of instructions about changing direction doubled the number of individuals achieving a solution.<sup>13</sup>

One difficulty in getting the proper direction is an inability to *reconstruct* the situation implicitly. Take, for example, the problem of the area of the square (p. 345). If this problem is completely novel, we must implicitly move the radius until it touches an edge. If we do this, the answer occurs in a flash. We see that the radius of the circle is one half of the side of the square. The match problem is solved, or well on the way to being solved, as soon as we implicitly place the matches into a tridimensional figure.

Professor Wertheimer studied thinking in children, observing them under various kinds of classroom instruction. What impressed him was the routine or "blind" nature of much that is taught, and the inflexibility of much of the thinking that results. He decried the

"emphasis on mechanical drill, on 'instantaneous response,' on developing blind, piecemeal habits." "Repetition," he said, "is useful, but continuous use of mechanical repetition also has harmful effects. It is dangerous because it induces habits of sheer mechanized action, blindness, tendencies to perform slavishly instead of thinking, instead of facing a problem freely."<sup>14</sup>

What Wertheimer was arguing for is the sort of thing stressed in the above experiments on direction in thinking — that is, to look at a problem in different ways, to seek new meanings, and to look for new combinations. The case of Gauss, the great mathematician, was cited by Wertheimer to illustrate the value of flexibility in thinking.

When Gauss was six years old his school teacher gave the class a problem in arithmetic, asking, "Which of you will be first to get the sum of  $1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9 + 10$ ?" Shortly afterwards, while the others were still busy figuring out the answer, Gauss raised his hand and said, "Here it is." Members of the class were doubtless saying "1 plus 2 is 3, and 3 is 6, and 4 more is 10," or something like this. Surprised by the child's quick answer, the teacher is reputed to have said, "How the devil did you get it so quickly?" We know the method that Gauss used (indeed he had hit upon

the gist of a very important mathematical theorem) but we do not know exactly what he replied. According to Wertheimer, from whom the above has been paraphrased, Gauss probably said something like this: "Had I done it by adding 1 and 2, then 3 to the sum, then 4 to the new result, and so on, it would have taken very long; and trying to do it quickly, I would likely have made mistakes. But you see, 1 and 10 make 11, 2 and 9 are again — must be — 11! And so on! There are 5 such pairs, 5 times 11 make

55."<sup>15</sup> The theorem is  $\text{sum} = (n + 1) \frac{n}{2}$ , and it of course applies as well for odd as for even numbered series.

How to achieve such flexibility of thinking is the problem. It occurs readily enough in a genius, who has the relevant information. But what about the rest of us? Such flexibility requires teaching for understanding, or insight at the same time that necessary drill is given. Several investigations have shown that this is possible in the schoolroom, even among children who do not have the mental calibre of a Gauss.<sup>16</sup>

The area problem of Figure 12.5 (p. 343) is another example of teaching for understanding instead of using rote methods.

## LANGUAGE AND THOUGHT

The view has often been expressed that thinking is "restrained speaking," "subvocal talking," or "implicit language activity." Reasoning can, however, occur without language. This was illustrated earlier by experiments on animals.

Even where language does exist, a certain amount of thinking is probably nonlinguistic. We may, for example, think about things for which we do not have names. In such instances we often have a visual or some other image of the thing thought about. Some psychologists have claimed that thinking can occur without involving either words or images.

After recognizing these limitations on the view that thinking is merely implicit language activity, we must admit that the symbols which represent most of the world are language symbols (verbal, gestural, or written), and that most of our thinking appears to be an internal manipulation of such symbols.

That thinking is closely tied up with inner speech is suggested by attempts to analyze thought processes. Try to analyze your everyday thinking and you will find that words are everywhere evident. It usually appears that, in thinking, you are talking to yourself. Children often do their thinking out loud for everyone to hear it — until they learn that it is customary, and usually worth while, to keep one's thoughts to oneself.

Thinking is often associated with activities of the speech mechanisms, especially of the tongue and throat in people who can hear and of the fingers in deaf mutes. In one study with hearing subjects, electrodes were placed on the tongue or underlip and connected with a sensitive galvanometer, an instrument which records electrical impulses (action currents) associated with nerve and muscle activity. When the subject imagined counting one-two-three, the indicator, which had been at rest, showed three marked series of excursions. Thus action currents were coming from the tongue or lips. Instructions like "imagine telling your friend the date," "recall a song or poem," "multiply certain numbers," and "think of eternity," brought action currents very similar to those involved in actually saying the words.<sup>17</sup>

Action currents are obtained from the hands of deaf mutes during thought.<sup>18</sup> Sometimes the activities of the hands are of sufficient magnitude to be detected with the naked eye. In one study, deaf mutes and normal subjects were asked to multiply mentally, divide mentally, and so on. Under these conditions, 80 per cent of the deaf mutes had action currents in the hands. Only 30 per cent of the hearing subjects showed such responses. The reason that hearing subjects exhibited action currents in the hands at all may be attributed to the fact that even they often use, or have used, their hands in making calculations — with or without using a pencil or chalk. The average magnitude of the responses obtained from the hands was about four times larger for the deaf mute than for the hearing subjects.

## IS THINKING NECESSARILY MOTOR?

According to the so-called *central* theory of

thinking, we think with our brains alone. This is contrasted with the *peripheral* or *motor* theory, which claims that we think with our whole body. The latter is better designated a *central-peripheral* theory, since it allows for the fact that engrams essential to thinking are somehow stored in the brain and that much of the integration involved is attributable to brain functions.<sup>19</sup> However, it emphasizes motor activities. Those of the vocal and gestural mechanisms have already been mentioned. One can also demonstrate that eye movements and other muscular activities are integrally involved in, or are at least concomitant with, the thought processes. For example, eye movements during attempts to imagine an object are often very similar to those made in the original examination of it.<sup>20</sup> Eye movements during recall are also often similar to those made in the original reading of what was recalled.<sup>21</sup> But other muscles may also be involved in thinking. One investigator found that thoughts of lifting a weight with the right hand were correlated with action currents in the biceps of the right arm.<sup>22</sup>

Findings like the above support the idea that thinking involves the whole body as well as the brain. But they do not allow us to conclude that motor activities, and even those of the vocal musculature, are in themselves the thought processes, or that they are essential aspects of thinking. A good argument could be made out to the effect that these motor activities are secondary, or merely incidental. It is conceivable that one could think on a purely central basis, without activity in his tongue, eyes, or other muscles.

A medical experiment with d-tubocurarine (curare), a drug which paralyzes the muscles without affecting the nervous system, lends support to the view that thinking can occur as a purely central process.<sup>23</sup> In this experiment, a healthy 34-year-old medical doctor was given a gradually increasing amount of d-tubocurarine until every muscle of his body was paralyzed. By speaking as long as he was able to do so, and thereafter by pre-arranged muscular movements in answer to questions, the subject kept in communication with the experimenters until paralysis was complete. A drug was then introduced which led to gradual recovery. Four hours elapsed from the time the first dose of the paralyzing

drug was given until the counteracting drug was injected. Electroencephalograms taken throughout this period were normal, even at the time of complete paralysis of the skeletal musculature. Thus the drug had no apparent central effect. What is of special interest to us here, however, is the fact that thought processes were reported to be normal. In the subsequent report of his experiences, the subject indicated that he was fully conscious and thinking even when completely paralyzed.

Although the subject of the above experiment reported no disturbances of his thought processes, it is conceivable that tests would have indicated limitations in the scope or flexibility of thinking. If this were so, we would have evidence that the motor mechanisms, while not essential, are at least contributory.

One cannot, in any event, overlook the essential contributions of the cerebral cortex, both as a repository of engrams and as an integrating mechanism. We shall later (Chapter 13) refer to the apparent significance of the frontal lobes in this connection.

Even when thinking is looked at from the standpoint of the central processes and motor mechanisms involved, we must recognize the importance of external stimuli in initiating and perhaps to some extent controlling it. The reader may recall, in this connection, the discovery (pp. 151–152) that conditions of relative isolation from external changes in stimulation often produce marked distortions of the thought processes.

## CONCEPTS

A concept is a process which represents the similarities in otherwise diverse objects, situations, or events. Concepts are products of reasoning and, once developed, play an important role in further thinking. A large proportion of the words in any complex language represents concepts. Words such as "tree," "dog," "liquid," "beauty," and thousands of others in our language, represent common aspects of things that are in many respects quite different one from the other.

In a sense, concepts are condensations of past experience. They bring together in a single idea, so to speak, what has been learned about properties of many different things.

Take, for example, the concept *tree*. This concept is foreign to certain Australian tribes. The native speaks of particular objects, like the jarrah, the mulga, and the gum, but he has no word to represent what is common to them all.

The development of concepts requires two processes known respectively as *abstracting* and *generalizing*. Sometimes the two cannot be separated clearly, but each of them is at least implied whenever a concept is formed.

Abstracting is observing the similarity of otherwise different things. The individuals who first invented the concept *tree* must have observed that trees, regardless of how much they differ, still have something in common. Likewise, the child, in acquiring the concept *tree*, or understanding the word "tree," must make similar observations. The child's first experience with a tree may be with a magnolia, with which it hears the word "tree" associated. But later on, the child hears the same word attached to the pine, an object of quite different appearance. Later still, it hears the oak called a tree. After a series of such experiences with a variety of trees, the child may see, let us say, a willow which has never before been called a tree in its presence. If it designates this a tree, the child must have observed something of what the willow has in common with other trees. But it must also have put aspects of previous experiences together with the present experience and reached the conclusion that this, being like the others in certain respects, is in the same category. Deriving a principle from varied experiences in this way is generalizing. A person might abstract without generalizing, but he could not achieve an adequate generalization, or concept, without first abstracting.

One should not gather the impression, from what we have just said, that the processes of abstracting and generalizing are necessarily deliberate, or even carried on consciously. In animals and human infants, our only evidence of abstraction and generalization comes from observation of similar reactions to different situations having a common characteristic. Looking at it from another angle, all we know is that different situations are equivalent from the standpoint of the reactions aroused and that this equivalence depends upon something which, despite their diversity, these situations

have in common.\* We do not know whether the subjects deliberately analyze the situations, and whether they are conscious of similarities and relations.

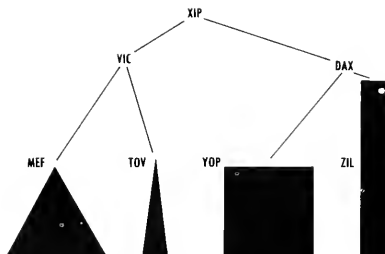
#### EXPERIMENTS ON CONCEPT FORMATION

Concepts have been developed, under experimental conditions, in a variety of organisms ranging from rats to men. A typical procedure with animals and infants is as follows: The subject is confronted with two forms and required to discriminate between them. These may, for example, be a triangle and a circle, as illustrated in Figure 12.9. Using a discrimination procedure (p. 227) a response to the triangle is rewarded and a response to the circle either not rewarded or punished. These figures are switched from side to side in a chance order so that the problem may be solved only by discriminating the visual stimuli. After the triangle is being selected with an accuracy approaching 100 per cent, a square, or some other figure, is substituted for the circle. This is to discover if the subject is responding negatively to the circle or positively to the triangle. Continued correct performance indicates the latter. Usually, the subject continues to select the triangle. We then replace the circle and *invert* the triangle. When we do this most animals respond as if confronted by a new problem. Accuracy of

\* A classic investigation of this general problem was carried out by Heinrich Klüver on monkeys. See his *Behavior Mechanisms in Monkeys*. University of Chicago Press, 1933. Reprinted 1957. Later investigators, including the writer, have extended this type of study to other animals, but to enlarge on this here would lead us too far afield.



**12.9 Concept Formation.** These are two forms between which the subject is required to discriminate in experiments of concept formation. The triangle is eventually inverted.



**12.10 A Generalization Problem.** After learning the specific names for each block, the child then learns that MEF and TOV are both VIC, that YOP and ZIL are both DAX, and that all the VIC and DAX blocks fall under the broader classification, XIP. Control tests used blocks of different dimensions but the same general shape. (From Welch, L., and L. Lang, "The Higher Structural Phases of Concept Formation of Children," *Journal of Psychology*, 1940, 9, 61.)

response drops from around 100 to around 50 per cent. It is apparent, in such instances, that what was being discriminated was a particular pattern of black and white, not a triangle *per se*. Monkeys and children have continued to select the inverted triangle. For these subjects, the inverted triangle and the original one were apparently equivalent. The subjects must have reacted in terms of triangularity, three-sidedness, or some other abstracted property which triangles have regardless of their position. Animals which fail to make this transition abruptly may be trained to respond to properties which otherwise dissimilar triangles possess. In one study, rats learned to respond to a large variety of triangles (small, large, upright, inverted, apex to right, apex to left) as equivalent, but over 1,000 trials, with frequent substitutions of triangles and further training, were required. In each trial the only constant aspect of the positive situation was the presence of some sort of triangle. All other concomitants varied. Finally some animals responded positively to triangles still different from those involved in training. They made a transfer, for example, to right-angled, equilateral, and outlined triangles. It is evident that these rats had learned to abstract tri-

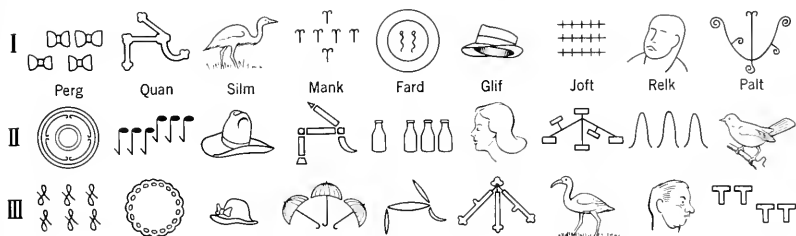
angularity, the only characteristic involved in all of the different kinds of triangles. The abstracted characteristic may have been three-comeredom, three-sidedness, or the like.<sup>24</sup>

Generalizing, and the development of concepts somewhat more complicated than in the experiments on triangularity, is illustrated by the materials in Figure 12.10. Here the child learns that each shape has its own name, such as MEF, TOV, YOP and ZIL. It also learns, however, that both MEF and TOV are VIC's; YOP and ZIL, DAX's. Finally it learns that all of these shapes, despite their differences, are alike in being XIP's. All of forty-five five- to seven-year-olds learned the first step. That is to say, they selected, from various blocks, the blocks with specific names. All but three also learned the second step. When asked for a VIC, they gave either MEF or TOV; when asked for a DAX, they gave either YOP or ZIL. The next step, however, was especially difficult and only twenty-two attained it within the limits of this experiment. A successful child could select a MEF, TOV, YOP or ZIL when asked for it. From a large assortment of shapes, he could pick out all the XIP's. And, when asked to remove the VIC's, he could take back MEF and TOV. Problems like this are comparable with calling a certain thing a worm, an animal, and also living matter. Many of our concepts are similarly hierarchical. They start with specific things and become increasingly inclusive.<sup>25</sup>

Another problem on concept formation is illustrated in Figure 12.11. Using an exposure apparatus to present one picture at a time, the experimenter asked the subject to name the picture as it occurred. Each picture had a nonsense name, as illustrated, but all figures possessing a common characteristic had the same name. For example, the pictures in the first row had, respectively, the following names: *Perg, Quan, Silm, Mank, Fard, Glif, Joft, Relk, Palt*. Look at the first picture in the second series. What is its name? Its name is *Fard*.

The subjects of course saw only one figure at a time and none was labeled. Moreover, they thought that the experiment was on memory. Their initial set, at least, was to memorize, not to abstract and generalize. Whenever the subject failed to respond in time, or said the wrong name, he was prompted. The





**12.11 Materials Used for Heidebreder's Experiment on Concept Formation.** The terms **Perg**, **Quan**, etc., represent concepts rather than particular pictures. What is **Perg** in the second line? In the third line? (After Heidebreder, 26, 95.)

experiment continued until each picture in sixteen strips like those illustrated was correctly named. With the material illustrated, you can test yourself on abstracting the common features of all the *Fards*, all the *Pergs* and so on. The outcomes of a long series of experiments using this type of material need not concern us here.<sup>26</sup>

A different test of concept formation utilizes the objects shown in Figure 12.12. Confronted with these items, the subject is asked to select any item, then place with it all of the articles he thinks belong with it. He may be asked to group articles with one that the examiner selects, or to group *all* articles which belong together. When the test is used in clinical psychology for diagnostic purposes, the patient is asked to arrange new groupings and also to say why the objects in a grouping arranged by the examiner belong together.

Some of the most frequent bases of grouping are: *use* (tools, eating utensils, edibles), *situation* (dinner setting, tools in a tool box), *color* (silver, brown, white), *form* (oblong, round), *double occurrence* (pairs — two lumps of sugar, two forks), and *material* (wood, metal).<sup>27</sup>

One can recognize immediately that this is a test of concepts, for what the subject is required to do is to group different things which have some common attribute. Children, schizophrenics, and patients with brain injuries tend to group the objects on a very *concrete* basis, such as the reds together or matches and candle together. Normal adults group on the basis of concrete aspects, but they are able to transcend the obvious similarities or associations and group on the basis of such abstract relations as "tools," "pleasure-giving objects," and so on. When an individual as-

**12.12 Objects Used in a Test of Abstract and Concrete Thinking.** This is the male form of the Gelb, Goldstein, Weigl, Scheerer Object Sorting Test, although the items are not arranged as in the standardized pattern. (From Goldstein, K., and M. Scheerer, 28, 80.)





**12.13 The Vigotsky Test of Conceptual Thinking as Adapted by Hanfmann and Kasanin.** The syllables indicating the respective categories are not visible to the subject except when, as described in the text, one of the blocks is turned up for inspection. Concrete responses would be responding to particular aspects, like putting all of the same shape together, all of the same size, all of the same color, or all of the same height. An intermediate level of conceptualization would be putting all blocks with corners together, or all colored or noncolored blocks together. The highest level of conceptual response, however, is to place all of the large tall blocks together in one group, all of the large flat blocks together in another group; and so on. The test could of course be changed to call for some other classificatory scheme, some such scheme as colored-flat, colored-tall, or green-flat-circular. (Courtesy C. H. Stoelting.)

sumes this conceptual approach “the presented articles are not taken as *individual* things, but as representative of a category. The subject deliberately disregards, abstracts from, the concrete singularity of the presented article.”<sup>28</sup>

Another test of conceptual thinking is illustrated in Figure 12.13. The blocks differ in color, shape, size, and height. Under each is a nonsense syllable. Those which belong to the same conceptual category have the same syllable. Thus, those that are both tall and large, irrespective of color or shape, belong to the LAG category; tall and small, to the MUR category; flat and large, to the BIK category; and flat and small, to the CEV category. The experimenter begins the test by turning over a block to show the category to which it belongs. He then asks the subject to select, from among all of the blocks, the ones which go with the sample. Suppose, now, that the sample is the green triangular block. The subject, responding on a concrete basis, might select either another green block or another triangular one. Whichever block it is, the experimenter turns it up and shows that it does not belong to the proper category. This procedure is followed in an effort to get the subject to learn the proper classification of each block, which is achieved only when single concrete properties of the blocks are disregarded and sorting is in terms of the dual properties, height and size.

### Teaching concept formation

Some investigators have sought to facilitate concept formation by discovering the best method of teaching individuals to proceed from the concrete to the abstract. In one such study, Chinese characters were used. These lend themselves to such research because each written word has within it a symbol which gives the “essence” of what it refers to. Thus several words that are in most respects quite different all have a common symbol which represents something which all have in common. For example, the symbol 木 is the word for wood. The following are the words for, respectively, table, bed, frame, tree, and forest: 檯 牀 架 樹 林. All are wood, so the symbol 木 appears in every word. Likewise the symbol for soil 土 appears in the words for land 地, grave 墳, dust 塵, and ditch 壕.

In the research on facilitation of concept formation, college students were shown Chinese characters like the above and, two and one-half seconds after each character was presented, a nonsense sound representing the characteristic which it had in common with certain others in the series was also presented. Thus all having the element 彳 were oo, all having the element 彳 were yer, and so on. Characters having the common element were mixed with others having a different common element.

The subjects were not told that they were doing an experiment on concept formation,

abstracting, or generalizing. Until they learned otherwise as a result of their experience, all thought that they were doing a memory experiment. They were merely asked to name the element (*oo*, *yer*, etc.) as the complex Chinese character containing it was presented.

Eventually it "dawned" on most of the subjects that the different *oo* characters, for example, were linked by a common factor—the  $\gamma$  embedded in each of the Chinese characters. The investigator says that "individual concepts usually came into consciousness very gradually. Erroneous first impressions were either discarded or transmuted into the correct form by a continuous development. Trial and error plays, if not a dominating, at least a very great rôle in the process."<sup>20</sup>

Various training procedures were used with different groups and each varied from the others in the readiness with which it produced conceptual responses. There was no difference in the efficiency of starting with simple characters and going to complex ones, on the one hand, and starting with complex characters and going to simple ones on the other. Nor was there any advantage to teaching the concepts out of their context—that is, by presenting the naked common elements. In identification with new complete Chinese characters, the individuals who had the concepts given them in naked form had to learn to discriminate them from the whole character. In this test, which is the sort of thing required in everyday life, neither those who had the concepts given them nor those who evolved them through trial-and-error learning had an advantage. A combination method in which naked characteristics were given, mixed in with the series of complete characters, was better than any other mentioned above. The most efficient method of all, as one might imagine, was to present the entire character, but with the common element redrawn in red so that it stood out or attracted attention.

Regardless of the precise method used, it is essential that the principle of dissociation by varying concomitants be followed if an adequate concept is to develop. This principle has been stated as follows: "What is associated now with one thing and now with another tends to become dissociated from either, and to grow into an object of abstract contempla-

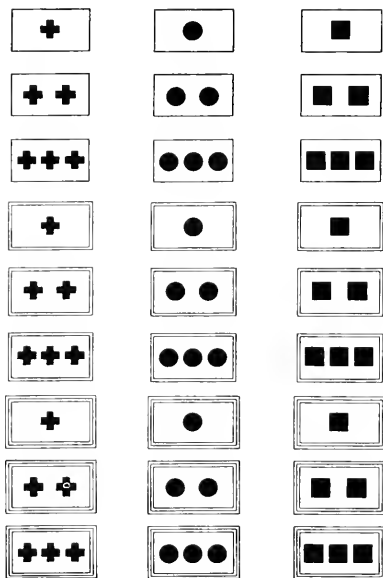
tion."<sup>30</sup> Thus, if the concept of triangularity is to develop, the triangularity must appear in different particular situations; if the concept *oo* is to develop, the character  $\gamma$  must appear now in one context and now in another; if the child is to develop an adequate concept *dog*, the word *dog* must be associated with white creatures, black ones, brown ones, large ones, small ones, smooth ones, rough ones, and so forth. The concept would never develop so long as only one dog, or one type of dog, was associated with the term *dog*.

### Individual strategies

So much for methods of presenting instances from which concepts may be derived. But how about concept formation from the standpoint of the learner? How does he come by his concepts? How does he learn that different items belong in the same category? In many instances, and especially in the categorizing of animals and infants, this process is a more or less passive one. That is to say, "The features common to a class of objects summate their impressions on the observer who thus gradually acquires a picture in which the common features stand out strongly while the variable characters are washed out."<sup>31</sup> In other instances there is an active search process. The individual develops the hypothesis that items having certain characteristics belong in the same category. He then tests this hypothesis by noting whether each new instance does or does not belong to the category.<sup>32</sup> Thus the child's hypothesis that all four-legged animals are dogs is supported when he hears one four-legged animal after another called "dog" but he must discard it when he hears a certain four-legged animal called "cat" or "horse."

Adults confronted with complex categorizing tasks take a quite evident problem-solving attitude. In attempting to discover the concept involved and in evaluating each new instance from the standpoint of whether or not it supports the hypothesis, various strategies may be adopted, some of which are more efficient than others. This was illustrated in a comprehensive investigation of categorizing behavior in college students.<sup>33</sup>

As an example of the type of materials used in the above-mentioned investigation, see Fig-



**12.14 Cards Used in An Experiment on Concept Formation.** This is the black set, but these cards were duplicated with red and with green figures, to make a total of 81 cards. Their use is described in the text. (From Bruner, J. S., J. J. Goodnow, and G. A. Austin, 33, p. 42.)

ure 12.14. In addition to these twenty-seven cards with black figures, there were comparable sets with, respectively, green and red figures. The cards were presented one at a time and the subject was not allowed to see former cards in the series. Any one of the eighty-one cards might be shown in a given instance. The subject was required to discover the concept that the investigator had in mind. Let us suppose that this was "any circle and a triple border." In this event, the card with three circles (bottom of the middle column of our figure) might be shown. The subject might hypothesize, on the basis of this sample, that the correct concept is "three circles and three borders." Next, let us sup-

pose, he is shown a card with a red cross and a double border. He is told that this *does not* exemplify the concept that the experimenter has in mind. Next he may be shown a card with a green circle and a triple border and told that this *does* exemplify the concept. The experiment proceeds thus until the concept is correctly stated and the subject shows that he can, in each instance, tell whether or not a particular card is an exemplar of the concept.

The strategy described above may be called "wholist" because the subject takes the entire initial card (three circles and three borders) as the basis of his tentative concept. Then he modifies this in terms of subsequent instances.

Another strategy may, by contrast, be designated "partist." The subject using this strategy bases his initial concept on only part of the first card—let us say, "three black circles." The next card of the above illustration (one red cross and a double border) is a negative instance, hence not at all informative. It tells nothing about the adequacy (or inadequacy) of the "three circle" concept. The next card (green circle and triple border) is informative. The experimenter indicates that this is a positive instance. Now the subject must give up the "three circle" hypothesis in favor of another. If he remembers former cards—which might be quite a task if many have preceded—he may hypothesize that "any circle" is the concept sought. This must be discarded, in turn, when a green circle with double border is shown and designated a negative instance.

In general, the wholist strategy is the more effective of those described. This is because the wholist's hypothesis "is modified at each step to incorporate the information gained from the instances he has encountered. He need never recall either his past hypotheses or the relation between these. *For his present hypothesis is a current summary of all these.* Only when he must recover from an error is recourse to memory necessary." However, the partist "must fall back on memory or the record" whenever something is shown which weakens or invalidates his hypothesis.<sup>34</sup>

Whether they use a whole or part approach, or shift from one to the other, as some subjects do, the participants in experiments like the above show other differences in strategy. Some adopt what has been called a "conserva-

tive strategy." They proceed cautiously and systematically, focusing on one feature at a time. Suppose, for example, that the first card has three red circles within a double border and that the concept to be discovered is "red circles." The next card has two red circles within a double border and is positive. Our methodical subject gets from this instance the information that three figures are not required. The next card has three green circles within a double border and it is negative. Our subject notes, from this instance, that he needs to retain red in the concept. Next he is shown three red crosses in a double border and informed that this is negative. From this is gained the knowledge that circle is relevant. Now he is given a card with three red circles and a single border. The card is positive, so he notes that two borders are not necessary. The problem is solved. The concept is "red circles." Every bit of information has been used in an efficient manner. Thus the concept has been achieved with a minimal amount of information.

Instead of concentrating on one feature at a time in the manner described, some subjects adopt a gambling strategy. They jump to conclusions. The first card, let us say, has three red circles and a double border and the concept is "three figures." The next card perhaps has three green crosses in a single border and the subject is told that it is positive. He concludes immediately that the concept is "three figures."<sup>35</sup> This is correct. He gambled and won. But suppose that the concept, involving the same cards, had been "three colored figures." The next card, let us say, has three black squares within a triple border and is of course designated negative. Now the subject must change his tactics. He must think back to the earlier cards and develop a new hypothesis by comparing these with the new instance. The conservative strategy, while it involves minimal risk from the standpoint of developing wrong concepts, is sometimes given up in favor of the gambling strategy. This is especially true when a limited number of instances is to be given or when time is limited and the concept has not yet been achieved.

#### Concept formation in everyday life

Many situations in everyday life do not in-

volve such obvious common elements as those of the experiments described above. Human beings not only acquire concepts by observing common elements and figuring out relationships, but they learn them by asking questions about things which puzzle them and getting answers in return. The child hears his parents talking about having time to do a certain chore, about its being time to go to bed, about something happening in time, and so on. Puzzled, he asks what time is. His parents may have great difficulty in explaining time, but what they tell the child leads to formation of a concept of *time*, adequate or inadequate. Take the concept *life*, as a further example. This may have both an observational basis and a basis in interrogation of elders. The child observes dead and living animals, and he observes, perhaps, that the living ones move and the dead ones do not. But concepts of *life* and *death* on this basis alone are likely to be far from adequate. Upon helping to bury the dead animal, the child may ask, "When is he going to wake up?" "Does he like being down there?" or, "How is he going to get out?" You then realize how limited the child's concept really is. You perhaps explain that animals once dead never wake up, and that they do not know anything, so can neither like nor dislike being buried. This process of observing, questioning, and getting answers goes on for years before the child has concepts of life and death which come close to those held by adults.

One method of finding out what concepts children already have is that of questioning them. Several investigators have used this method to discover how particular concepts develop with age and experience. The child is asked, for example, "Do you know what it is to be alive?" A reply to this question brings further questions.

Thus, a boy of eight years was asked, "Is the sun alive?" to which he answered, "Yes." Asked, "Why?" he replied: "It gives light. It is alive when it is giving light, but it isn't alive when it is not giving light." Asked, "Is a bicycle alive?" the child replied: "No, when it doesn't go, it isn't alive. When it goes, it is alive." To the question, "Is a mountain alive?" the child answered, "No." The query, "Why not?" brought the reply, "Because it doesn't do anything." It is obvious that for this child the concept *life* means ability to

move or do something. By way of comparison, let us take the more mature concept of a twelve-year-old boy similarly questioned. The boy said that he knew what it meant to be alive. He was then asked, "Is a fly alive?" He said, "Yes," and, upon being asked, "Why?" he replied, "If it wasn't alive it couldn't fly." To the question, "Is a bicycle alive?" the boy replied, "No." "Why not?" brought the reply, "Because it is we who make it go." Further questioning verified the fact that this boy attributed life to anything that could move of its own volition.<sup>36</sup>

Using a standardized questioning procedure and standardized objects, investigators have studied the development of the "life" concept in thousands of school children.<sup>37</sup> Animism, or the attributing of life to inanimate objects, is usually found to go through stages somewhat like those already suggested. At first a child attributes life to *anything in good condition*. Broken objects, for example, are excluded. Life is later attributed only to *objects which move*. Later still, it is attributed only to *objects which move spontaneously* or, as suggested above, of their own volition. The concept is still further refined when it is applied only to *plants and animals*.

There is no definite correlation between age and stages of concept formation. Bright children may develop the more adequate concept earlier than other children, but they probably go through comparable stages in achieving it.<sup>38</sup> There is, however, some question about the universality of this process. White, Indian, and Negro children in American schools respond in the manner described above.<sup>39</sup> But somewhat different results have been found in China<sup>40</sup> and in a South Sea Island group.<sup>41</sup> This discrepancy has, however, been attributed to the fact that the latter investigations used procedures different from those of the other studies.

An interesting outcome of research on animism is the discovery that many college students have apparently failed to outgrow animistic concepts. It is not uncommon, for example, to find students maintaining that a lighted match is alive or that the sun is alive because it gives forth energy. The lowest incidence of animism has been found in biology students.<sup>42</sup>

There is no doubt that many adult con-

cepts are inadequate from the standpoint of the scientist or the philosopher. But, inadequate as they may be, our concepts give us an advantage in thinking about our world and ourselves which would be lost if we were compelled to speak and think about particulars only.

## CREATIVE THINKING

Many of man's creative works develop gradually, as if by a process of trial-and-error. One of the first attempts at developing a locomotive, for example, was a boatlike structure with a sail and wheels which ran on tracks. Next, a horse running on a treadmill was used for motive power. Then, a horse pulled the carriages along the tracks. The steam-driven vehicle which followed had many obvious defects—it was so uncertain in action, actually, that a horse-drawn "train" raced it. There were then gradual refinements of locomotives, leading up to our present streamliners. Despite the obvious trial-and-error progress here represented, there were many inspirations which made successive steps in the development of the locomotive possible. And so it is with all creative work. There is an evident need to produce something different, then attempts to produce it, followed, quite often, by significant insights.

There is currently much interest in creativity—from the standpoint of what creative thinkers are like (intellectually and as persons) and from the standpoint of the creative process itself.<sup>43</sup> Studies of creative intelligence have used specially designed tests to measure differences in originality, imagination, and related processes. Some of the findings have been factor analyzed in an effort to discover the "basic ingredients" of creativity.<sup>44</sup> The personality of creative individuals (architects, artists, composers, novelists, and others) has also been studied with tests, principally of such things as artistic judgment, independence, and self feelings. These studies have shown, among other things, that creative people, as compared with the ordinary, are more

\* There is also a great deal of current interest in the years of man's greatest creativity. Actually, the age of maximum creative accomplishment varies with the individual and the field in which creativeness occurs. See Lehman, H. C., *Age and Achievement*. Princeton University Press, 1953.



**12.15 The Four Stages of Creative Thought.** These drawings illustrate what is described by Poincaré as follows: "For fifteen days I strove to prove that there could not be any functions like those I have since called Fuchsian functions. I was then very ignorant; every day I seated myself at my work table, stayed an hour or two, tried a great number of combinations and reached no results. One evening contrary to my custom, I drank black coffee and could not sleep. Ideas rose in crowds; I felt them collide until pairs interlocked, so to speak, making a stable combination. By the next morning I had established the existence of a class of Fuchsian functions, those which come from the hypergeometric series; I had only to write out the results, which took but a few hours.

"Then I wanted to represent these functions by the quotient of two series; this idea was perfectly conscious and deliberate, the analogy with elliptic functions guided me. I asked myself what properties these series must have if they existed, and I succeeded without difficulty in forming the series I have called theta-Fuchsian.

"Just at this time I left Caen, where I was then living, to go on a geologic excursion under the auspices of the school of mines. The changes of travel made me forget my mathematical work. Having reached Coutances, we entered an omnibus to go some place or other. At the moment when I put my foot on the step the idea came to me, without anything in my former thoughts seeming to have paved the way for it, that the transformations I had used to define the Fuchsian functions were identical with those of non-Euclidean geometry. I did not verify the idea; I should not have had time, as, upon taking my seat in the omnibus, I went on with a conversation already commenced, but I felt a perfect certainty. On my return to Caen, for conscience' sake I verified the result at my leisure." (From Poincaré, H., "Mathematical Creation," as edited and presented by J. R. Newman in *Scientific American*. Drawings by Stanley Meltzoff.)

"vigorous and have available to them an exceptional fund of psychic and physical energy"; live "more complex lives, seeking tension in the interest of the pleasure they obtain upon its discharge"; and have "more contact . . . with the unconscious — with fantasy, reverie, the world of imagination."<sup>44</sup> This is of course just the sort of outcome that one might expect from general contact with creative people.

What is of most interest to us here is not so much the intelligence or personality of creative individuals as the process involved in creative problem-solving. Several political theorists, artists, and scientists have either analyzed their own thinking or had the products of their thought analyzed by others in an attempt to discover something of the creative process. It is generally agreed, as a result of these studies, that creative thinking often passes through three or four, more or less definite stages. These are: (1) *preparation*, (2) *incubation*, (3) *inspiration or illumination*, and (4) *verification or revision*.<sup>45</sup> Henri Poincaré, the great French mathematician, who also wrote about the process of creative thinking, experienced these stages. In Figure 12.15, he is pictured solving a mathematical problem.

### Preparation

All education is, of course, a preparation for creative thinking, although we may not use its products creatively. Specialized education, like training in medicine, is preparation for creative thinking along special lines. The doctor's education gives him the information (symbolic processes) which prepares him for possible creative thinking in medicine. The inventor of electrical devices must have preparation along electrical lines. Einstein's concept of relativity would never have occurred to him had he not first learned advanced physics and mathematics.

In addition to this general preparation for possible creative thinking, one needs specific preparation for specific problems. Thus, a doctor confronted by some especially difficult medical problem may have to consult other authorities about various aspects of the general problem before being able to reach a conclusion concerning it. Even in preparing a term paper, which may at times be a creative

activity, you must first acquaint yourself with relevant facts concerning the topic about which you are to write. A comparable "soaking-up" of facts is the required preparation for any creative work.

Preparation for creative thinking often includes attempts to relate facts in various ways. There is much trial and error. Perhaps there is pacing of the floor or biting of fingernails. You attempt to write your term paper; you may write something; tear up what you have written; and start over again, only to tear that up in disgust. Edison remarked that much of his inspiration was actually perspiration, referring, perhaps, to this sort of preparational activity.

### Incubation

This stage of creative thinking is characterized by absence of overt activity, or in many instances even of thinking about the problem. Sometimes, however, certain ideas concerning the problem recur. Poets and artists report the following details about their incubation periods:

The idea smoulders in my mind until completed.

I have an idea in the back of my mind for a long time, sometimes a week or two. I don't think constantly about it, but it keeps coming back.

I often carry an idea around for several weeks before I make a picture, though sometimes longer. I got ideas in Santa Fe last summer to do now. The ideas recur from time to time while I am occupied with other things.<sup>46</sup>

This is a period of no obvious progress. Some creative thinkers intentionally put all thoughts of their problem in the background after preparing themselves. Some go for a stroll, read light literature, engage in a game of golf, or perhaps have a sleep.

The stage which follows incubation has led some to assume that, while the creative thinker turns his attention elsewhere, his problem is being solved unconsciously. This would be difficult, if not impossible, either to prove or disprove. It is likely that associational activities initiated by attempts to solve the



problem continue to some degree. We see some evidences of this in connection with dreams. The individual may give up his problem and go to bed, only to have aspects of it appear in his sleep. There is no reason to believe otherwise than that the associational processes would continue in a similar manner were he to remain awake and engage in other activities. This continuance of associational activities, once started, has already been referred to as *perseveration*.

### Inspiration

Most creative thinkers claim that their creative ideas, following the period of incubation, come to them suddenly. The significant ideas may occur at any time, sometimes even while the thinker is dreaming.

In writing your creative theme, you have doubtless been discouraged by an evident lack of progress, when suddenly the material seemed to organize itself, the relevant ideas came copiously and rapidly, and what had been obscure became clear. One will recognize that this process resembles the process of insight during other forms of learning activity. It is often, as in those instances, preceded by a certain amount of trial and error.

Trial-and-error activity, however, is usually considered part of the preparation rather than the incubation stage of creative thinking. Several creative thinkers have pointed out that their trial-and-error activity apparently led nowhere, and that it was only after they put the problem aside that inspiration came.

We should not overlook the insights which sometimes occur when there is no evident problem. In science, and in other areas of creative endeavor, it often happens that the individual whose background has prepared him for it discovers something he is not looking for.\* The discovery of penicillin by Sir Alexander Fleming is a good illustration.

While talking with Pryce, a colleague who had dropped in to see him. Sir Alexander began to examine some Petri dishes containing

old cultures of staphylococci. As Maurois describes the subsequent event:

Several of the cultures had been contaminated with mould—a not unusual occurrence. “As soon as you uncover a culture dish, something tiresome is sure to happen. Things fall out of the air.” Suddenly he stopped talking, then, after a moment’s observation, said, in his usual unconcerned tones: “That’s funny. . . .” On the culture at which he was looking there was a growth of mould, as on several of the others, but on this particular one, all around the mould, the colonies of staphylococci had been dissolved and, instead of forming opaque yellow masses, looked like drops of dew.

Pryce had often seen old microbial colonies which for various reasons had dissolved. He thought that probably the mould was producing acids, which are harmful to the staphylococci—no unusual occurrence. But, noting the keen interest with which Fleming was examining the phenomenon, he said: “That’s how you discovered lysozyme.” Fleming made no answer. He was busy taking a little piece of the mould with his scalpel, and putting it in a tube of broth. Then he picked off a scrap measuring about one square millimetre, which floated on the surface of the broth. He obviously wanted to make quite sure that this mysterious mould would be preserved.

“What struck me,” Pryce says, “was that he didn’t confine himself to observing, but took action at once. Lots of people observe a phenomenon, feeling that it may be important, but they don’t get beyond being surprised—after which, they forget. That was never the case with Fleming. I remember another incident—One of my cultures had not been successful, and he told me to be sure of getting everything possible out of my mistakes. . . .”

Fleming put the Petri dish aside . . . He showed it to one of his colleagues: “Take a look at that,” he said, “it’s interesting—the kind of thing I like; it may turn out to be important.” The colleague in question looked at the dish, then handed it back with a polite: “Yes, very interesting.” But Fleming, in no way discouraged by this manifestation of indifference, temporarily abandoned his investigation of the staphylococci, and gave

\* This is sometimes referred to as “serendipity,” a word coined by Horace Walpole (*The Three Princes of Serendip*) to “denote the faculty of making lucky and unexpected ‘finds.’” The three princes were “always making discoveries, by accident and sagacity, of things they were not in quest of it.”<sup>47</sup>

himself entirely to studying the surprising mould.<sup>48</sup>

#### Verification or revision

Inspiration is sometimes the final stage in creative thinking. In most instances, however, it is necessary to evaluate, test out, and perhaps revise, the idea that comes to us. Is it logical? We can at times determine whether an idea is logical by casting it into syllogistic form and testing it by the laws of formal logic. Very often, however, it is necessary to carry out controlled observations which will prove whether or not an inspira-

tion is correct, or workable, or needs revision.

This is the method followed by scientists. Likewise, the inventor must show that his ideas work in practice as well as in his blueprints. Indeed, the scientist, inventor, and artist frequently find that their inspirations need considerable modification before their creative work is satisfactory.

The inspiration is, so to speak, only a prelude to further intensive work. It is one thing for the person to get the idea for a picture, a novel, a poem, an invention, or a theory, and quite another to paint the picture, write the novel, write the poem, produce the invention, or formulate, test, and verify the theory.

## Summary

Thinking is manipulating the world internally, using modifications of the organism which represent the things that produced them, i.e., symbolic processes. The term *thinking* covers such activities as thinking of (or recalling) something; reverie, or free association; fantasy, or daydreaming; and reasoning, or implicit problem-solving. We have given major attention to the latter process.

The existence of reasoning in animals ranging from rat to man is clearly indicated by results obtained with several learning problems. These are problems which could not conceivably be learned without the use of symbols.

One type of reasoning problem gives the subject two separate "experiences" and then confronts him with a problem he can solve immediately only by combining these experiences. Rats had solved simple problems of this nature.

Certain multiple-choice problems have also been solved by animals below man. These problems require a response to relationship, such as to the middle door or key, of a constantly varying number of doors or keys presented in varying positions.

The double-alternation problem utilizes a temporal maze, one in which the subject is required to make a temporally related series of reactions, for example, a right-right-left-left

sequence, without differential sensory cues to guide him. The ability to solve this problem and to extend the sequence beyond that involved in training increases as we go up the scale from rat to man. In human children, ability to solve the double-alternation problem increases with age. The problem is quite readily learned by adults, the subject saying, "*right, right, left, left,*" as he responds.

In all reasoning, three things are requisite: retention, recall, and recombination of what is recalled. So-called "thinking machines" have such processes built into them, but their computing is dependent upon a detailed programming of routines to be followed. Their activities resemble human reasoning only in its elemental aspects.

When confronted by problems or difficulties which cannot be met in a routine manner, human beings make inferences concerning the cause of their difficulties or the solutions of their problems. This is the most important step in human reasoning. Inferences are made on the basis of past experience, and they are limited in scope and relevance by the limitations of experience. Before accepting or rejecting inferences we usually evaluate them, either by further implicit activity or by carrying out an actual check on their applicability.

Our associational processes in reasoning are

directed by the nature of the problem, as we conceive it. The problem gives us a set, or determining tendency, which facilitates recall of certain items and inhibits recall of others not relevant to the situation. Sometimes, despite this general directional tendency, we are hindered by limitations which we place on our own thinking. We accept the first inference that comes to mind, perhaps, and let our thoughts go in the direction suggested. Delusions often have such a basis. The reasoning process is more efficient when we change direction frequently, seeking new inferences when the one we have does not work.

Much of human thinking involves subvocal talking. Evidence for this view comes from such observations as the following: children "think out loud" before they learn to think subvocally, organs involved in speech give rise to action currents while a person is thinking, action currents come from the fingers while deaf mutes are engaged in thought, and eye movements such as are involved in reading may recur when the individual is thinking of what he has read. There are also action currents from other relevant muscle groups, as from the biceps while a person thinks of an action which involves these muscles.

Despite all such motor concomitants of the thought process, thinking still occurs during complete paralysis. This was brought out in the experiment with curare. It suggests that, while thinking normally involves the vocal and other motor mechanisms, it can occur on a purely central basis, i.e., in the brain.

The brain is involved in thinking in at least three ways: it contains modifications (engrams) which represent past experience, it mediates recall, and it activates and integrates the various activities of the vocal and other mechanisms normally involved.

Many of the terms used in thinking represent common properties of things that are diverse. These are conceptual terms, and the ideational processes which underlie them are called concepts. Acquiring concepts requires that the individual discriminate the common

properties of different objects—that he discern similarity amid diversity. This is the process known as abstracting. In order to develop a concept, it is also necessary that the individual generalize—that he relate the similarities in such a manner as to derive a generalization like "all objects having these properties are trees."

The general method followed in concept formation is dissociation by varying concomitants. Research on concept formation in adults, using Chinese characters, suggests that the more efficient method of teaching individuals to abstract and generalize is that of presenting total situations with the common elements emphasized. The common properties of many situations which call for concept formation are by no means obvious, and the individual must "figure them out." Individuals confronted by difficult concept (categorizing) problems use different strategies, some of which are more efficient than others. Many concepts are learned by asking questions. Children's concepts, at first very inadequate, gradually approach those of their elders.

Creative thinking is especially evident in the productions of such people as scientists, inventors, artists, and poets. Much trial-and-error underlies most creative work. Inspirations, insights, or illuminations are its spectacular aspects. Analysis of creative thinking by the thinkers themselves, and by others, has led to the conclusion that four stages are more or less clearly evident. These are: preparation, the gathering of relevant information and attempts to organize it; incubation, a period of relative inactivity, perhaps with recurrence of ideas about the problem, but no evident progress; inspiration, the sudden illumination, or "aha" experience; and verification or revision, the testing-out and evaluation of the idea, inference, or hypothesis, either by implicit processes or by actual experiment. The last stage is not always present, but it is required whenever anything is done about the inspiration. It is essential in research and in certain inventive pursuits.

(References and notes for this chapter are on page 563 of the Appendix.)

## Selected Readings

- Anderson, H. H. (Ed.), *Creativity and its Cultivation*. Harper, 1959. A series of papers. Those by Guilford, Hilgard, and Stoddard are relevant to our discussion.
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- Whorf, B. L., *Language, Thought, and Reality*. Wiley, 1956. Papers selected and edited by J. B. Carroll, whose introduction is a fascinating account of a most interesting man. The basic idea throughout the several papers that are relevant to our present discussion is that language shapes man's concept of reality and also his thought processes. The papers on thinking in primitive communities (p. 65), the relation of habitual thought and behavior to language (p. 134), and language, mind, and reality (p. 246) are especially worth reading.
- Stevens, S. S. (Ed.), *Handbook of Experimental Psychology*. Wiley, 1951. See the chapter by Leeper entitled "Cognitive Processes."
- Woodworth, R. S., and H. Schlosberg, *Experimental Psychology* (Rev. Ed.). Holt, 1954. Chapter 26 deals more extensively with the topic of the present chapter.

# Knowing Our World

## 13



Sensory stimuli • Sensitivity • The nerve impulse • Central mechanisms • A closer look at cortical functions • Visual reception • Auditory reception • Static sensitivity • Kinesthesia • Olfactory sensitivity • Taste sensitivity • Organic sensitivity • The skin senses • Summary

Everything that we know of the world around us comes from the impingement of stimuli on sense organs and the resulting activation of receptors, nerve fibers, and brain cells. This is true whether experience is direct, as in watching a sunset or hearing a symphony, or indirect, as in looking at pictures, reading, or listening to descriptions of what we have not ourselves experienced. Likewise, everything that we do is dependent, in the last analysis, upon information encoded in messages from our receptors.

Receptors are often referred to as “gateways to knowledge,” and with good reason. The most important of these “gateways” are of course our visual and auditory receptors, but receptors in the skin, the nose, and the mouth are also significant avenues of information about the world around us. In addition to these senses, concerned primarily with stimuli originating in our external environment, there are three others which bring information about our own bodies and their position in space. With one of these, the kinesthetic sense, we are already quite familiar, since it was referred to as providing informational feedback during the learning and performance of motor skills. Another, the static sense, is concerned with equilibrium. Both the kinesthetic and static senses play an important part, not only in telling us about the position of our limbs and the orientation of our body as a whole, but also in facilitating general bodily

coordination. The organic sense was mentioned in discussing the visceral components of emotional experience. This underlies such experiences as nausea, stomach cramps, and bladder tensions.

Each sensory process involves a succession of events beginning with stimulation of receptors. Resulting receptor activities encode messages for the brain. These coded messages are conveyed as nerve impulses. They go to centers in the spinal cord and/or brain stem. They are then relayed to the cerebral cortex. The meaningfulness of nerve impulses — the sensory information that they provide — depends upon their point of origin (in which receptor they were initiated) and their destination in the cerebral cortex. When nerve impulses reach their destination they are decoded and integrated with other information. The outcome is information concerning the world around us and about our own body. What we do about this information is also dependent upon nerve impulses, in this instance impulses going from the brain or spinal cord into our muscles and glands.

In this chapter we are concerned more with input than output — more with knowing than with doing — hence emphasis is given to reception, to related neural events, and to the information which these provide. Such information is no doubt a limited representation of the world around us, and it is not always free from error, as will be apparent when illusions are discussed, but it is all the information that we have.<sup>1</sup>

### SENSORY STIMULI

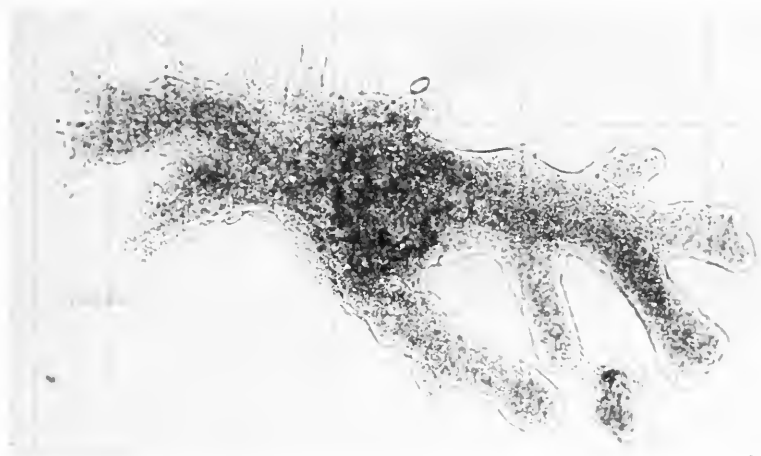
A stimulus is anything inside or outside of our body which initiates activity of some kind. Sensory stimuli are those which activate our sense organs. There are many aspects of the environment, however, which fail to stimulate us. We cannot be aware of these aspects, except through instruments which record their presence, or through the reactions of other organisms sensitive to them. This is because we have no receptors attuned to such features of the environment. Visual stimuli, for example, are light waves which range in length from about 390 to 760 millionths of a millimeter. Wave lengths above and below these limits are ineffective visually. Similarly, the range of auditory stimuli is limited. Sound waves of about 20 to 20,000 cycles (double vibrations per second) stimulate our auditory receptors and arouse corresponding experiences of pitch, but frequencies outside of this range are without effect. Some animals have a more extended auditory range than we do. Dogs, for example, respond to frequencies which we cannot hear. A dog whistle cannot be heard by us because its frequency is above the range to which our own receptors are attuned. Our olfactory (smell) receptors are attuned to certain chemicals in gaseous form. The gusta-

tory sense (taste) is also stimulated chemically, in this instance by liquids.

Receptors in our skin are attuned to mechanical and thermal stimulation, giving information about the tactual properties of objects. Kinesthesia depends upon stimulation provided by movements in muscles, tendons and joints. The stimuli are pressures and pulls on these structures. Static sensitivity is aroused by stimulation associated with movements of the head and the body as a whole. Such movements activate receptors in the equilibratory mechanisms of our inner ear. The stimuli for organic sensitivity are gases, tissue changes, and chemical activities associated with gastric and other internal processes.

### SENSITIVITY

Although all animals are to some degree attuned to their environment, some have no receptors and many have receptors very different from our own. The whole body of an amoeba (Figure 13.1) is responsive to light, to contacts of various kinds, and to chemicals. No part is more sensitive, or differently sensitive, than any other part. Since specialized receptors are lacking, the amoeba is sensitive to its environment only in a very limited way. Take light, for instance. Only its brightness,



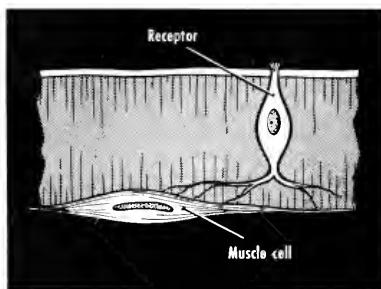
**13.1 An Amoeba.** An amoeba is a single-celled organism which combines within itself, insofar as the properties are shown at all, the capacity to serve as a receptor, as an effector, and as a conductor of the results of stimulation. This photomicrograph shows an amoeba extending long pseudopods toward another microscopic organism. Each of the large ruled squares in this picture is one-hundredth of an inch on a side. (From Buchsbaum, R., *Animals Without Backbones*, Revised Edition. Chicago: University of Chicago Press, 1948, p. 14-1. Photo by Ralph Buchsbaum.)

direction and movement are effective. The characteristics of light which in higher animals give rise to perceptions of color, shape, depth and other details of the visual world are lost on an amoeba because it has no receptors attuned to them. The same situation exists with respect to other features of the world. Although an amoeba is sensitive to mechanical vibration applied more or less directly to its body, it is insensitive to weak vibrations carried through the air, hence it is completely deaf. This is because it lacks auditory receptors. The amoeba is generally responsive to chemical stimuli in contact with its body, but it possesses no specialized chemical senses — no taste or smell.

An amoeba also lacks nervous mechanisms. Certain effects of stimulation are conducted to the part which moves, but conduction is diffuse. Since there are no specialized moving organs (effectors), any part may become a

pseudopod and, as it were, reach out or contract in response to stimulation.

Receptors, nerve cells, and effectors evolved together. Many lower organisms have muscle cells which respond directly to stimulation. One touches such a cell, for example, and it contracts. Animals somewhat higher in the scale have definite receptors and definite muscle cells and the two are in contact, as pictured in Figure 13.2. Now stimulation of a receptor activates a muscle cell through the receptor's nerverlike projections. In still higher forms of animal life, receptors and effectors are connected via an intervening neural link, one form of which is shown in Figure 13.3. The intervening link between receptors and effectors developed increasing complexity so that, in time there developed a highly complex and intricately integrated nervous system. In higher forms of animal life this became a spinal cord and brain (the central nervous system)



**13.2 A Muscle Cell Activated Directly by a Receptor.** An impulse traveling along the receptor unit activates a muscle cell, causing it to contract. (After Parker.)

with incoming and outgoing branches (the peripheral nervous system). Somewhere in this development the brain became sufficiently complex to mediate awareness of the surrounding world as well as to interconnect receptors and effectors. Thus we not only make overt responses to light, but we also *see* colors and other visual aspects of our surroundings.

**13.3 A Simple Receptor-Effector System.** Here the receptor carries impulses to an intervening nerve net which, in turn, activates muscle cells. (After Parker.)



The general pattern of the nervous system of higher organisms is illustrated in Figure 13.4. This shows schematically that receptors (in this case cutaneous) send impulses into the spinal cord where they interconnect with: (1) fibers going to muscles on the same level and (2) fibers ascending to the cerebral cortex. The first level of integration is a *reflex arc*. This sort of interconnection is involved when we withdraw our hand from a pin prick. The second level is necessary for sensory awareness, as when we feel the pain of the prick. Whenever we do something about the information coming to our brain (over ascending pathways), impulses must pass downward and interconnect at lower levels, as suggested by the descending pathway in our sketch.

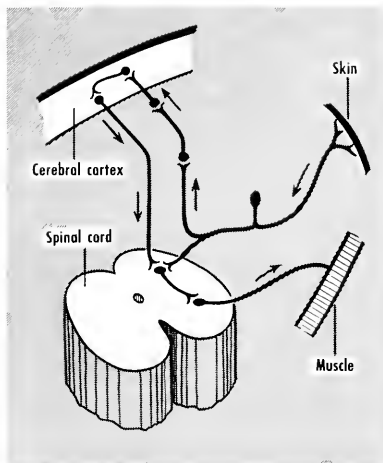
Cerebral connections in higher organisms are exceedingly complex. An impulse entering the cortex may set off widespread activity, hence our sketch is grossly oversimplified. Actually the input and output are themselves very complex, involving activities in many incoming and many outgoing fibers. The incoming impulses, and the resulting central interconnections, underlie the decoding of information in sensory terms. Outgoing impulses of course determine what we do about the information that our brain receives.

Instead of being welded together into a network, as in Figure 13.3, the nerve fibers of higher organisms are interconnected through synapses. The breaks indicated in Figure 13.4 show some places where synapses occur. Nerve impulses are slowed up and may even be inhibited in synapses, so that they go no farther. On the other hand, an impulse entering a synaptic junction may start up activity in many interconnecting fibers. This is what usually happens within the central nervous system.

The separate nerve elements are called *neurons*. Each consists of a nerve cell and various projections. Fibers carrying impulses toward the cell body are *dendrites*; those carrying it beyond the cell body, *axons*. Many nerve fibers are quite elongated. Those which connect our toes with our spinal cord, for example, may be as long as three feet.

Neurons carrying impulses to the spinal cord or brain stem are referred to as *afferent*, or *sensory*; those carrying impulses toward muscles and glands as *efferent*, or *motor*. Interconnecting neurons, such as those which exist





**13.4 A Schematic Representation of Some Neural Circuits in the Brain and Spinal Cord.** Connections on only one side are shown. This diagram, which is simplified to an extreme degree, shows a reflex arc, an ascending and a descending pathway, and upper connections. (After Herrick.)

within the brain and spinal cord are referred to as *connector*, or *association*, neurons.

Fibers in the peripheral nervous system form bundles. These are the *nerves*. When a nerve is cut across and magnified sufficiently, it looks like a cable in which each nerve fiber corresponds to an insulated wire. As illustrated in Figure 13.5, insulation is provided by a fatty sheath known as *myelin*.

In considering the details of sensitivity we are more interested in neurons than in nerves, for each neuron, except at synaptic junctions, is conceived of as functioning independently.

What is the nature of the impulse which travels along a nerve fiber when the receptor to which it is attached is stimulated? It is to this question that we now address ourselves.

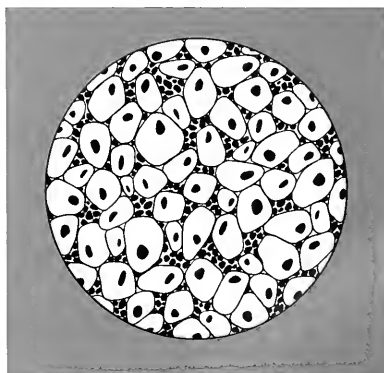
### THE NERVE IMPULSE

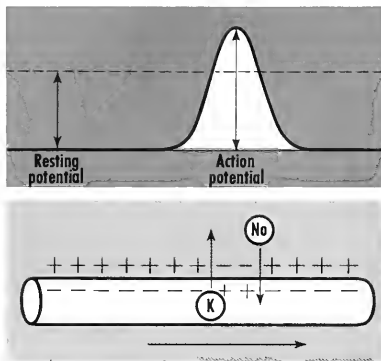
According to a widely accepted theory, each nerve fiber possesses a semi-permeable mem-

brane which, as pictured schematically in Figure 13.6, has positive electrical charges outside and negative electrical charges within. While in this state the fiber is said to be *polarized*. Each part is, in effect, a tiny battery with its positive and negative poles. When the fiber is stimulated (either by receptor activity or activity produced in the synapse by impulses in adjacent fibers) the membrane in that region becomes more permeable. The positive and negative charges then unite. This union produces a similar effect in the immediately adjacent part of the fiber, that in the next, and so on, until the electrical (and chemical) disturbance has traveled the length of the fiber. Electrical recordings picked up from nerve fibers demonstrate that stimulation is followed by a wave of negative electrical potential, which sweeps the entire length of the fiber. This *action current* or *propagated disturbance* is what we refer to in speaking of the nerve impulse.

The speed of transmission of a nerve impulse

**13.5 Cross Section of a Nerve.** Each nerve is a bundle of fibers, much like a cable. This cross section represents schematically two kinds of fibers found in some nerves. The black dots are axons; the white sheath is myelin. Note that some fibers are large and heavily myelinated while others are small and have little or no myelin sheath. Impulses travel more slowly in small than in large fibers. (After Livingstan.)





**13.6 The Nerve Impulse.** The action potential is represented at the top; the nerve fiber at the bottom. "During the rise of the action potential, sodium ions (Na) enter the fiber and make it positive; during the resting state . . . the outward pressure of potassium ions (K) keeps the fiber interior negative." (From Katz, B., "The Nerve Impulse," *Scientific American*, Nov. 1952, p. 61.)

is fastest in the relatively thick nerve fibers. At its maximum, this is about four miles a minute.

#### The all-or-nothing principle

Impulses traveling along a particular nerve fiber have the same potential, regardless of the nature or intensity of the activating stimulus. The reason for this is that a stimulus does no more than release energy already in the fiber. It does not contribute energy. What we have is analogous to a chain of gunpowder. The magnitude of the resulting disturbance is the same whether we ignite the powder with a spark, torch, or trigger blow. In the case of gunpowder, there is an all-or-nothing effect. We get a complete explosion or none at all. Similarly, the nerve fiber is discharged completely or not at all. Once activation occurs, a wave of electrical potential of the same magnitude at each point travels to the end of the fiber. This property which the nerve fiber has of responding completely or not at all is known as the *all-or-nothing* principle.

If part of the fiber is immersed in a narcotizing solution such as alcohol, the potential is weaker while an impulse passes through the solution. The impulse returns to normal, however, in the part of the fiber beyond the solution. This is further proof of the fact that the energy utilized is in the fiber and has nothing to do with the nature of the stimulus which starts the impulse.

#### The refractory period

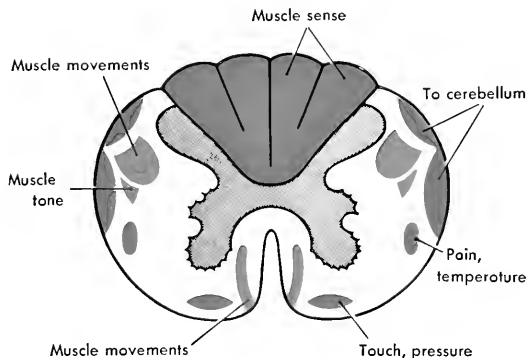
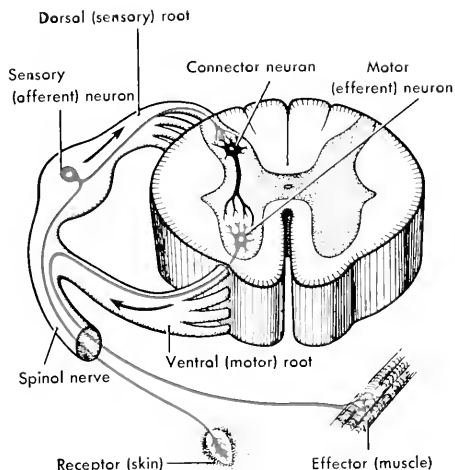
Shortly after an impulse has passed and a section of nerve fiber has thus undergone depolarization, there is re-establishment of the original state. Then another impulse may travel along the fiber. The interval between passage of an impulse and recovery is known as the *absolute refractory period*. This interval differs from fiber to fiber. Its shortest duration is about one thousandth of a second.

During the absolute refractory period no form of stimulation, of whatever strength, will start a nerve impulse. After this brief period, however, there is a progressive increase in excitability so that stronger than normal stimulation may produce a response. This interval between the absolute refractory phase and a normal excitability level is known as the *relative refractory period*. In order to be effective, a stimulus applied early in this period must have much greater than normal intensity. As excitability builds up, however, progressively weaker intensities may become effective. The more intense the stimulus, therefore, the sooner it can activate a fiber that has recently responded. This means that a stronger stimulus produces impulses more frequently than does a weaker one (Figure 13.7). The *frequency* of nerve impulses is thus seen as a function of the intensity of the stimulus.

The optic nerve has an estimated 400,000 fibers. Light excites many of these. An increase in stimulus intensity activates still more. Hence, increasing the intensity has two immediate effects: it *increases the frequency* of discharge in each responding fiber and it *activates more fibers*.

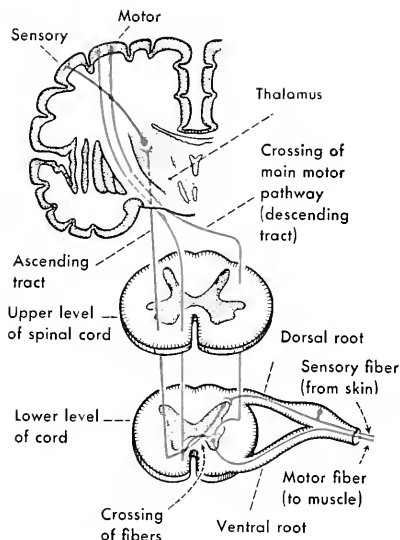
Sensory nerves carry impulses which, as indicated earlier, may eventually reach specialized areas of the brain. When impulses reach such areas, we have corresponding sensitivity. The optic nerves, for example, send their im-

**A Spinal Cord Cross Section.** The pathway shown schematically here is greatly simplified. Actually there are many incoming, connector, and outgoing fibers as well as connections with ascending and descending paths in the spinal cord. This reflex has three types of units. Some, like the knee jerk, require only two. As described in the text, sensory neurons in this case synapse directly with motor neurons.



**Some Tracts in the Spinal Cord.** Tracts shown in red are descending (motor) and those in blue ascending (sensory). Several sensory tracts are not represented. (After Carlson and Johnson.)

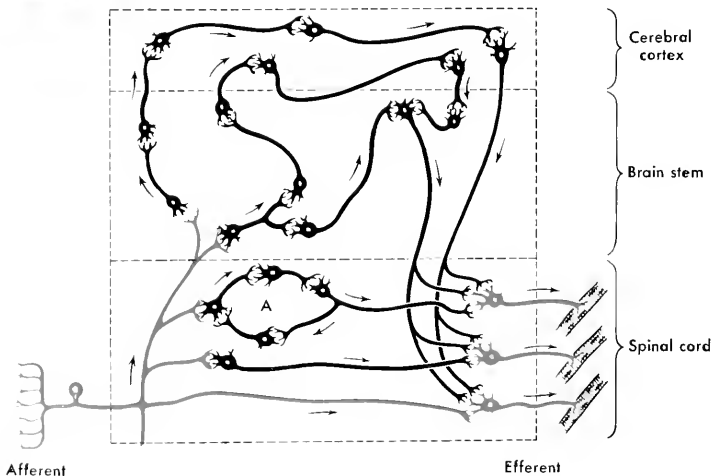
# PLATE 3



**Sensory and Motor Pathways.** Sensory pathways are shown in blue; motor pathways in red. Impulses from skin receptors (pain and temperature) enter over sensory (afferent) fibers, via the dorsal (back) root of the spinal nerve. Some impulses cross the gray matter of the cord and go up the tract which terminates in the thalamus. From there impulses may go, via a different set of fibers, to the appropriate sensory area of the cortex. Note that these impulses (pain and temperature) cross at the level on which they enter the spinal cord. Other fibers (not shown) ascend on the side on which they enter, and cross later. All ascending fibers thus eventually cross to the opposite side from that on which they enter the cord. Impulses from the motor area of the cortex also cross to the opposite side of the body, some in the lower region of the brain and others in the cord at the level at which contact is made with the motor (efferent) fibers. Descending tracts connect with motor fibers leaving via the ventral (front) root of the spinal nerves. Observe that concentrations of cell bodies, as in the cerebral cortex and in the butterfly-shaped central region of the spinal cord, are represented as gray. These are often referred to, respectively, as the "gray matter" of the cortex and spinal cord. (After Carlson and Johnson.)

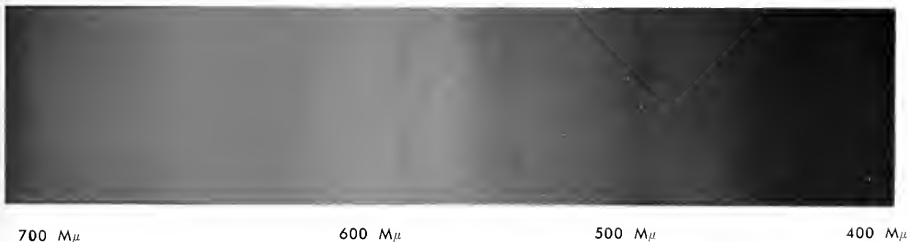
# PLATE 4

**Some Interconnecting Circuits.** Note the reverberating circuit (feedback) at A. (After Ranson and Clark.)

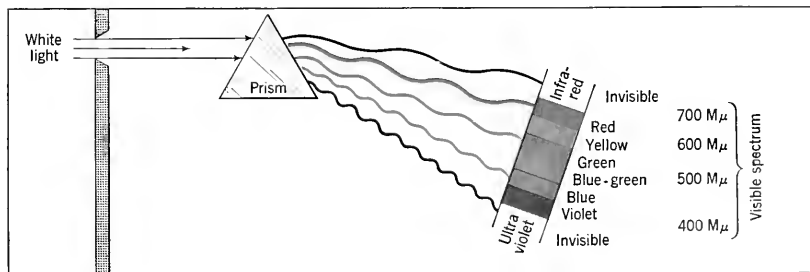


## The Range of Wave Lengths Correlated with Vision.

One millimicron ( $m\mu$ ) is a thousandth of a micron and one micron ( $\mu$ ) is one thousandth of a millimeter. Thus one millimicron is a millionth of a millimeter.

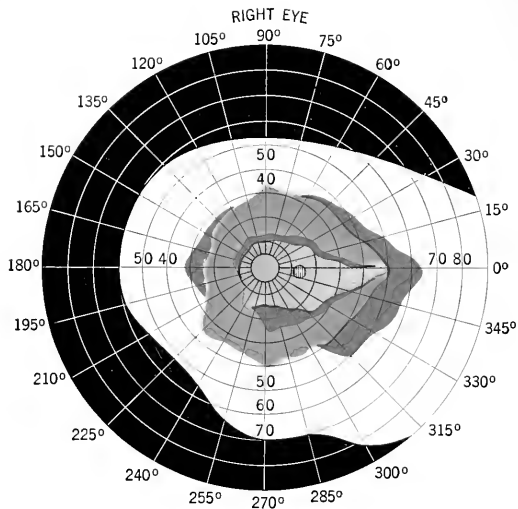


**Use of a Prism.** This shows how different components of white light are separated to produce the visible spectrum.

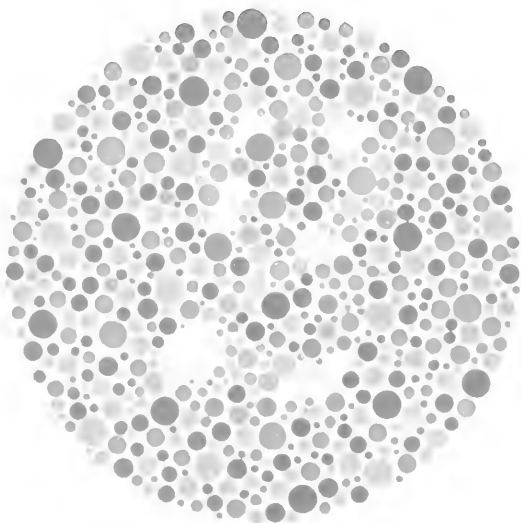


# PLATE 7

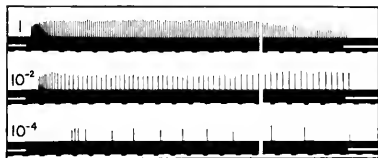
**Color Zones of the Retina.**  
This chart shows areas of color sensitivity for the right eye. (See text.)



# PLATE 8



**Chart for the Detection of Color Blindness.** A person with red-green blindness sees the figure 2. The person with normal color vision sees the figure 5. If you observe closely, you will notice that the discs which make up the 5 differ from the background in hue, but that their brightness differs in a random manner over a wide range and is not distinguished from the brightness of discs outside of the figure. This random arrangement of discs with respect to brightness makes it impossible for an individual who is red-green blind to see the number. Look again. You may notice that certain discs of different brightness from the others are arranged systematically to form a figure of some kind. It is a 2. You will have difficulty in tracing it; your set for hue may make it impossible for you to do so. However, the individual who cannot see the hues, but who is especially set for brightness, cannot help seeing the 2. (Copied by permission from Ishihara's "Series of Plates Designed as Tests for Color Blindness," Tokio, 1920.)



### 13.7 Action Potentials in an Optic Nerve Fiber.

These action potentials were taken from a king crab's optic nerve fiber while its retina was stimulated with steady illumination of three different intensities (represented at the left). Time markings (at the bottom of the record) are in  $\frac{1}{10}$  sec. intervals. Note that the relatively high intensity (top) produced many more impulses per unit of time than did the intermediate intensity. The weakest intensity produced a low frequency of impulses. (From Hartline, H. K., *Harvey Lectures*, 1941.)

pulses to brain areas specialized for vision. When these impulses reach such areas we see, and when there is a sufficient increase in the number of impulses pouring into these regions, what we see is seen as brighter. From the foregoing, it is apparent that some of this increase comes from a greater frequency of impulses per fiber and some of it from the fact that more fibers are involved. The same principles apply to hearing and the other senses.

To recapitulate: each impulse triggered by a strong stimulus has the same potential as one set off by a weaker stimulus (the all-or-nothing principle), but there are more impulses per second with the stronger than with the weaker stimulus (the frequency principle). The stronger stimulus may also activate more fibers. The experienced intensity associated with stimulation is dependent upon the number of impulses reaching the relevant part of the brain. This represents a combination of the number of fibers activated and the frequency of discharge in each. Increased magnitude of muscular response has a similar explanation.

### CENTRAL MECHANISMS

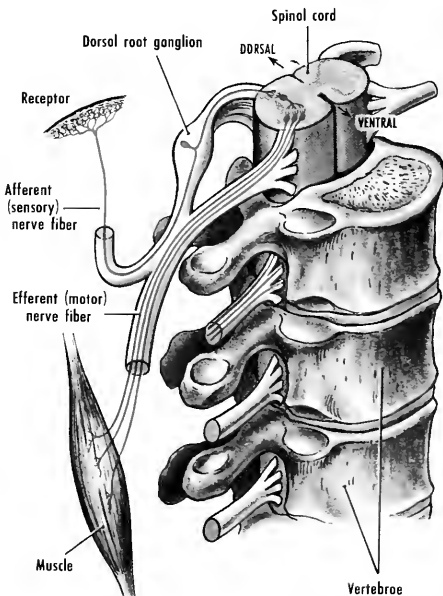
The central nervous system, as mentioned earlier, comprises the spinal cord and brain.

Both are conducting and integrating mechanisms, although the integrations of greatest complexity occur in the brain. Major divisions of the brain are the *brain stem*, the *cerebellum* and the *cerebrum*. The latter is divided into two *cerebral hemispheres*. The outer surface of the cerebrum is the *cerebral cortex*.

### The spinal cord

The spinal nerves run into the cord between the vertebrae (see Figure 13.8). Each nerve has two roots, a *dorsal* (toward the back) and a *ventral* (toward the belly). The former carry afferent (sensory) and the latter efferent (motor) impulses. Thus, if the dorsal fibers were cut, one would lose sensitivity in the part of the body connected with them. However,

**13.8 The Spinal Cord.** The cord runs along the center of the vertebral column, and the spinal nerves emerge between the vertebrae.



if the ventral fibers were cut, the connected part of the body would be paralyzed. In polio, ventral cells are destroyed, hence the corresponding paralysis.

Impulses entering the spinal cord may connect directly, or via connector neurons, with efferent neurons on the same level (Plate 1), thus forming reflex arcs like those already discussed. Connections of this nature underlie reflexes such as the knee jerk (a minimum of two neural links) and withdrawal of the hand from a painful stimulus (involving at least three neural links).

In an intact organism, however, impulses are seldom (if ever) confined to particular segments. Some ascend the spinal cord and, in the brain stem, cerebellum, or cerebrum, give rise to impulses which descend the cord to connect with efferent neurons. The ascending and descending paths form definite spinal tracts, as illustrated in Plate 2. Plate 3 shows the general nature of spinal and higher connectings. Sensory impulses (ascending) are represented in blue and motor impulses (descending) in red. All ascending impulses cross to the other side, some at the level of

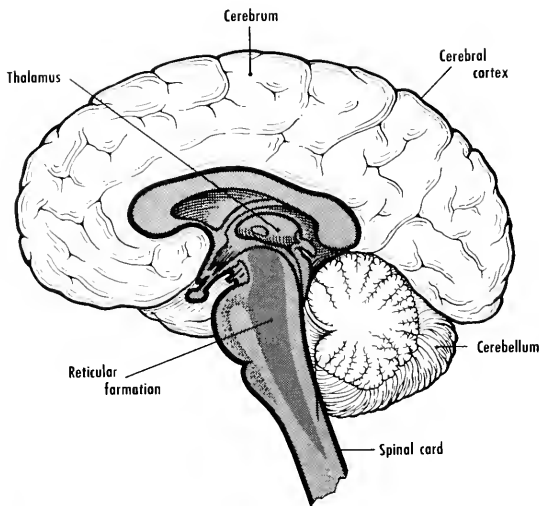
entry and some higher up. Likewise, all impulses from the motor control regions of the cerebral cortex eventually reach effectors on the opposite side of the body.

At the center of the spinal cord, as also seen in Plates 2 and 3, is a butterfly-shaped mass of *gray matter*. This contains association neurons and cell bodies of efferent neurons. The ascending and descending tracts form the *white matter* of the spinal cord. They have a whitish appearance because the fibers within are covered by a white fatty sheath.

### The brain stem

All nerves which do not enter the spinal cord reach the central nervous system via the brain stem. Because they enter the head (cranium) these are designated *cranial nerves*. Afferent cranial nerves come from such sensory structures as taste receptors, the eyes, and the ears.

All impulses traveling between the spinal cord and the cerebral cortex must run through the brain stem. Many make synaptic connections at this level with (1) cranial nerves,



## 13.9 The Relations of the Brain Stem to the Cerebrum and Cerebellum.

The brain stem is shown in grey. Within it, running from the lower to the upper part, as represented here, is the *reticular formation*. This is a network of fibers which discharges diffusely when activated. Among other effects, this discharge alters the cerebral cortex, readying it for reception of incoming sensory messages. Most of the impulses which reach and activate the reticular formation are conveyed by side branches of fibers carrying impulses to the *thalamus*. The thalamus is an elaborate switchboard mechanism for projection upon the cerebral cortex of impulses coming from receptors — impulses from the skin are sent, via the thalamus, to one part of the cortex, impulses from the eyes to another, and so on.



(2) other ascending or descending fibers, and (3) important integrating centers within the brain stem itself. Some such connections are schematically represented in Plate 4. This also shows how impulses, once they enter a circuit, may continue to travel around it. Such *reverberating circuits* occur at all levels of the central nervous system, but they are especially active within the brain stem and cerebellum. Circuits involving various structures of the brain stem and cerebellum are responsible for the control of such automatic and usually unconscious acts as breathing, maintaining equilibrium, and walking. Take walking, for example. Each leg muscle responds to nerve impulses from the brain stem. The resulting contractions stimulate kinesthetic receptors within the muscle. Thus impulses are sent back to the central nervous system. A continual feedback of this nature keeps the brain stem informed about activities in muscles from one moment to the next. It is this feedback which allows walking to occur as it does — coordinated, yet without our having to attend to what our muscles are doing.

The general anatomy of the brain stem is shown in Figure 13.9, the legend of which identifies and describes the functions of some of its major structures.

### The cerebellum

This is a major mechanism for coordinating reflex activities in different parts of the body, activities like those involved in the flying of birds, in the swimming of fish, in walking, and even in speaking and writing.

The cerebellum has widespread connections with various parts of the brain stem, including the reticular formation. There are also connections with ascending and descending pathways in the spinal cord. Impulses are fed into the cerebellum from static receptors and from kinesthetic receptors in the muscles, tendons, and joints. Incoming impulses have an informative function. Those of static origin indicate the changing positions of the body as a whole. Kinesthetic impulses indicate the changing activities (the contractions and relaxations) of muscles throughout the body. Such information is integrated in the cerebellum and associated mechanisms. Thus impulses returning to the motor mechanism

initiate the proper reactions, and in appropriate sequences.

### The cerebrum

The cerebrum becomes larger and more elaborate as we go from lower animals to man. Its surface turns inward (invaginates) in many places to form a large number of convolutions, thus providing a more extensive surface within the limited space of the cranium. The significance of this is that it provides space for an increasing number of brain cells. These become concentrated in the outer surface of the cerebrum and form the cerebral cortex: literally, the brain's bark.

In each of the cerebral hemispheres there are four lobes, three of which are particularly specialized to decode messages from receptors.

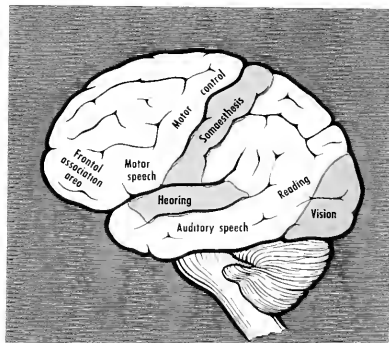
The lobes of the left cerebral hemisphere are pictured in Figures 13.10 and 13.11. The first of these gives a representation of the outer surface of the hemisphere while the other shows some detail of the projection paths to specialized sensory and motor areas.

### A CLOSER LOOK AT CORTICAL FUNCTIONS

The cerebral cortex has four basic functions: to *receive* messages from sensory brain centers related to the receptors, to *send* messages to the effectors under its control, to *retain* certain effects of past activity, and to *integrate* incoming and outgoing impulses, often in terms of what has been retained from the past. The retaining and integrating functions are together referred to as *associative*. With one exception having to do with speech, all of the above functions are served equally by corresponding areas in *both* cerebral hemispheres.

Specialized areas for reception of impulses originating in receptors are located in the parietal, occipital, and temporal lobes.

The *parietal* lobes receive impulses from *somaesthetic* (body-feeling) receptors in the skin and from the kinesthetic receptors in muscles, tendons, and joints. In patients whose cortex has been exposed prior to brain surgery, electrical stimulation within a parietal area is often followed immediately by such statements as, "My hand feels warm," "I have electrical feelings in my leg," or "I can feel my leg



### 13.10 The Left Cerebral Hemisphere, Showing Association and Specialized Sensory Areas.

Note that each sensory association area is adjacent to the specialized reception area for the same sense. The motor speech area is in the lower motor area, the area concerned with control of motor activity in the head region.

moving," even though the limbs mentioned are not stimulated.<sup>2</sup> Such feelings are referred to the opposite side of the body—that is, stimulation of the right parietal lobe leads to feelings in limbs on the left side of the body. This is because, as pointed out earlier, tracts ascending the spinal cord cross to the opposite side from that on which they originated.

The visual areas are in the *occipital lobes*. Each eye, as will be apparent in more detail when we discuss vision, sends impulses to both occipital lobes. Later we shall also observe that ability to differentiate visual details, including color differences like red and blue, depends upon the dispersion in this region of impulses originating in various structures of the eyes. Surgeons have noted that electrical stimulation within the occipital cortex leads to visual experiences, like flashing lights, whirling colors, and sometimes stars or particular colors such as pink or blue.

Impulses from our auditory receptors go to the *temporal lobes*. A given ear is represented in both lobes, as indicated more fully in the discussion of hearing. Direct stimulation of a

temporal lobe may produce humming, buzzing, or other auditory experiences.

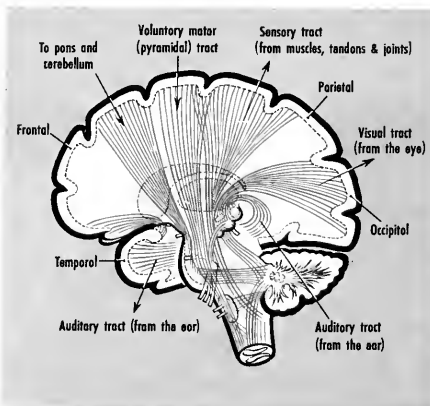
Our other senses do not have such clearly established cortical locations as is the case with somesthesia, vision, and hearing. Even one of the somesthetic senses, that of pain, has no clear cortical representation. Surgeons carrying out necessary operations have, in different patients, cut into every part of the cerebral cortex, yet without reports of pain.<sup>6</sup> This sense is possibly mediated at subcortical levels.

Our motor cortex is a relatively narrow strip of tissue running along the posterior part of the frontal lobe as illustrated in the preceding figures. It is from this region that voluntary motor activities, including speech, are initiated.

<sup>6</sup> The only pain is that experienced while the scalp is being penetrated prior to the brain operation. This pain can of course be prevented by use of a local anesthetic.

### 13.11 Projection Paths of the Brain.

The sensory projections begin in the thalamus. Here impulses from the eyes are switched to the occipital, those from the ears to the temporal, and those from the muscles and skin to the somesthetic region. Observe at the bottom of the brain stem that some motor fibers cross to the other side while some descend on the same side.



Adjacent to each of the motor areas proper are motor association areas of great importance for speaking and writing. Except for its motor control areas, the frontal lobe is concerned solely with associative functions and it apparently plays an especially significant role in higher processes like thinking and reasoning.

Some of the association areas, as shown in Figure 13.10, are adjacent to those specialized for sensory reception. Thus there are visual, auditory, and somesthetic association areas. These retain relevant sensory information and relate it to incoming impulses. Red light, for example, starts visual impulses which eventually reach the visual area of our occipital cortex. But red also arouses such associations as "danger" or "stop." This is because the visual association area, retaining effects of our former experiences with red light, is also aroused by stimulation with red light. It adds "meaning" to this stimulation. Similarly, sounds and tactual experiences are given meaning in accordance with relevant past experiences.

The significance of tactual association may be illustrated by reference to a disease known as *astereognosis*, meaning, literally, without tactual knowledge of space. If you were blindfolded and then asked to handle such objects as a small cube, a ball, or a pyramid, you would have no difficulty in naming these objects. But if you subsequently suffered a serious impairment of your tactual association areas, you would be unable to recognize them through touch alone. This would be because loss of the association tissue caused tactual impressions to lose the meaning they once had for you.

When associative disorders involve language functions, we speak of *aphasia*; meaning, without speech. Sensory aphasia results from injury to the visual and auditory association areas (Figure 13.10). The visual impressions reaching your eyes from this print have meaning for you only because the relevant association areas retain what you have learned about the significance of the marks seen. Similarly, you understand what you hear only because your auditory association areas give meaning to what would otherwise be meaningless sounds. When the functioning of these visual or auditory association areas is seriously disturbed, therefore, the individual has an impairment of the corresponding speech functions. The disturbance may be so serious that, al-

though he sees written words, and can even trace them, he does not understand what they mean. Similarly, a patient may be able to hear but without understanding what he hears.

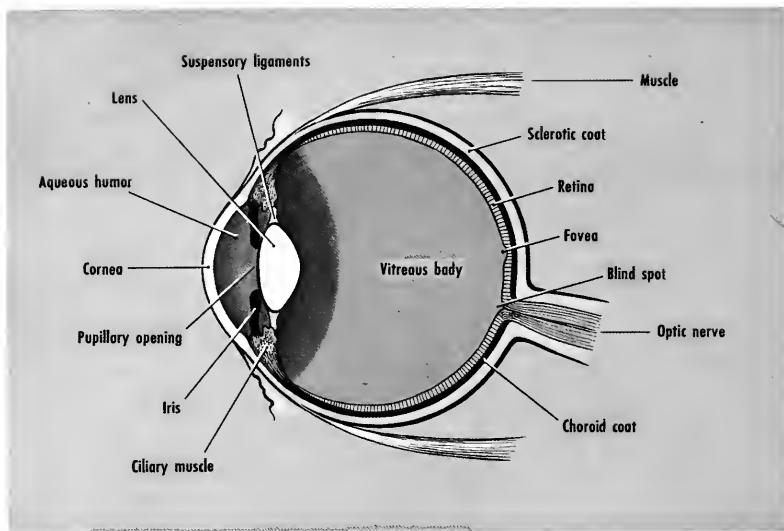
This general survey of the nature of stimulation and of the mechanisms which transmit and integrate the information provided by it prepares us for a closer examination of receptors, receptor functions, and the various kinds of sensitivity associated with them.

## VISUAL RECEPTION

Light is looked upon as composed of electromagnetic waves, waves of radiant energy emanating from a source, ultimately the sun. We said earlier, in discussing stimulation, that the eye is attuned to only a relatively narrow range of wave lengths. The range is from slightly below 400 to slightly above 700 millionths of a millimeter, as suggested by the spectrum in Plate 5. White light is a mixture of all wave lengths, but when it is broken down into various wave lengths, as illustrated in Plate 6, we observe that the shorter waves underlie our experience of violet and the longer waves our experience of red. Intermediate wave lengths give rise to blue, green, and yellow.

The term *hue* represents what we commonly call color, or chromatic vision. Thus, the red, blue, green and yellow of the spectrum are hues. Colors also vary in *saturation*; that is to say, in their richness or purity. Thus a red may be very red or only reddish, as in the case of a pink. Hues are qualitative aspects of visual experience. But there is also a quantitative aspect, that commonly referred to as *brightness*. This term applies to achromatic vision (to white, black, gray) as well as to chromatic vision. Thus a gray may be bright or dull, and so may a red.<sup>3</sup> While hue is correlated with the length of light waves, brightness is correlated with the amount of displacement (or amplitude) of waves, which determines their energy level. Experienced brightness is also related to adaptation, as will be evident later.

The eye has millions of light-sensitive cells. These are in the *retina*, the inner lining of the eyeball (Figure 13.12). In addition to various supporting tissues, this has two major types of receptor elements, the *rods* and *cones* (Figure 13.13). When stimulated under normal light



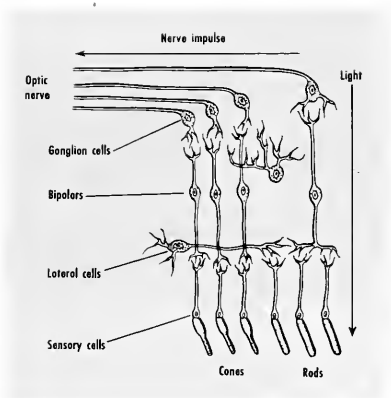
**13.12 A Cross Section of the Human Eye.** Light rays entering the eye pass through the tough glossy cornea, a watery liquid known as the aqueous humor, the pupil, and the lens. The pupillary opening varies in size, depending upon the intensity of light. These changes are brought about through reactions of the iris, which thus serves a function comparable with that of the diaphragm in a camera. The curvature of the lens needs to change from time to time. This adjustment, known as accommodation, is carried out reflexly through changes in the ciliary muscle and the suspensory ligaments. After passing through the jelly-like vitreous body, light rays produce an image on the retina. Clearest vision is in the fovea, an especially sensitive depression. Nearby is the blind spot, the point at which nerve fibers leave the retina. The walls of the eye comprise the outer tough covering known as the sclerotic coat, an intermediate heavily pigmented layer known as the choroid coat, which keeps out all light except that which comes through the pupil, and the retina, which is an extremely complex photosensitive mechanism for translating photic stimulation into nerve impulses.

conditions the rods and the cones respond photochemically and resulting nerve impulses, when they reach the occipital cortex (Figure 13.14) provide a wide range of information about the visual scene.

Rod vision is solely achromatic. That is to say, it is concerned only with whites, blacks and grays. Animals whose retinæ contain only rods are color blind.

The cones mediate chromatic vision. It is their response which gives us our color sensi-

tivity. Under low illumination, as at twilight, however, the cones cease to function. Then we see only with our rods, and color has gone. The fovea of our eye (Figure 13.12), the point of clearest vision, is without rods. It is thickly packed with cones and is sensitive to all colors. In twilight, however, cones cease functioning and the fovea is thus completely blind. Outside of the fovea there are both cones and rods, but the cones thin out as the outer region (periphery) of the retina is approached. Thus,



**13.13 The Human Retina.** The rods and cones face away from the front of the eye and, as indicated by the arrow, light must pass through the neural elements of the retina in order to stimulate them. When it reaches a layer of pigment in close proximity to the rods and cones, it stimulates their tips, thus arousing nerve impulses. These impulses pass to the bipolars and then to the ganglion cells of the optic nerve, which carries them to the brain. Most of the canes, as illustrated, have their own "private" paths to the brain whereas two or more rods usually share the same pathway. (After Bortley.)

as shown in Plate 7, color vision is present in the fovea, and around it for a certain distance and then, as cones disappear, the retina becomes color blind. Observe that one sees blue and yellow farther out on the periphery than either red or green.

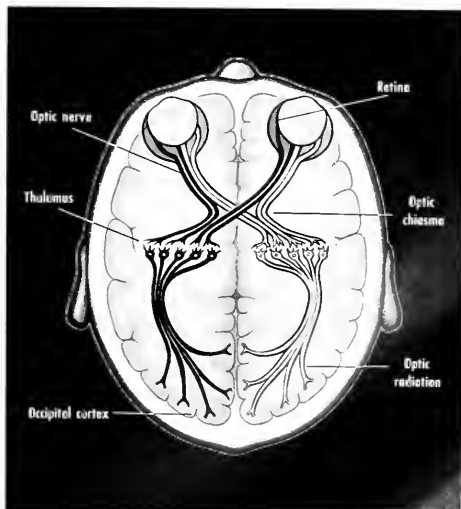
While it is clearly established that cones mediate color vision, very little is definitely known about how they do it; there are, however, many theories, each trying to explain

color phenomena in terms of activities within the cones, or within the nervous system.

It appears fairly obvious that there are different kinds of cones, attuned to different wave lengths, but the major question is how many different kinds are needed to account for the phenomena of color vision. One theory supposes that there are three types, especially responsive to, respectively, the long (red), intermediate (green) and short (blue) wave

### 13.14 Route of the Optic Fibers to the Brain.

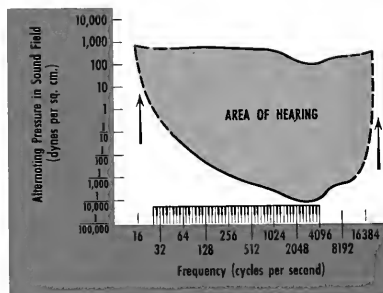
The fibers shown in solid black represent those mediating vision in the left half of each eye; those in white, the right half of each eye. Observe that fibers from the right half of each eye go to the right side of the brain and fibers from the left half of each eye go to the left side of the brain. Crossing occurs in the optic chiasma. Thus, if your right optic pathway were severed between the optic chiasma and the brain, you would be blind in the right half of each eye. If the optic chiasma were cut where the fibers cross, you would be blind in the inner (nasal) region of both eyes. From the retina, optic nerve fibers go to the thalamus. There they synapse with fibers of the optic radiation, which carry impulses to the occipital cortex.



lengths. Yellow is thought to depend upon simultaneous stimulation of the "red" and "green" cones and it is indeed possible to obtain yellow by overlapping red and green patches of light. Yellow is also obtained when one eye is stimulated with red and the other with green by using a special stereoscopic device.<sup>4</sup>

In this brief survey we cannot consider color color phenomena and color theories in detail.<sup>5</sup> But we should note some facts of great importance for color vision. These were taken up earlier but they need reiterating. Here they are:

If a nerve cell is excited at all, it is excited to its maximum extent (all-or-nothing principle) and any difference in the experience aroused thus depends upon (1) how many fibers are activated, (2) the frequency of discharge in particular fibers, and (3) where the impulses go. The number of fibers activated and the frequency of discharge in each is determined by the intensity of stimulation and, in the case of vision, this underlies brightness differences. Where impulses begin determines, to a major degree, where they go. Thus impulses beginning in the retina lead to differential excitation of neurons in the occipital cortex of the brain. Within this region, however, there must be a differential termination of impulses from different kinds of cones. If three different types are necessary to mediate the range of color experiences, impulses from these must terminate in different places within the visual area of the cortex. Everything that we have learned about the nervous system shows us that impulses from one kind of receptor are just like those from another — hence impulses from "red" cones could be no different, *in kind*, from those initiated in "green" cones. This means that the qualities of color experience — its various hues — must depend upon different responses of the cortex to impulses originating in different receptor elements and terminating in different places. There is as yet no direct evidence of such a difference in locus for impulses from different types of cones. One reason for this is that since all cones look alike, physiologists are unable to identify "red," "green," and "blue" cones. If a cortical differentiation should exist, and we knew where to stimulate, we might arouse experiences of red, blue, or of green by stimulating at the respective terminals.



**13.15 The Limits of Human Hearing.** Observe that the range of frequency for the piano is from 28 to 4096 cycles per second. (After an illustration in the Encyclopaedia Britannica film, "Fundamentals of Acoustics.")

In order to be perfectly adequate, a theory of color vision would not only need to take the above facts into consideration but it would also have to explain why, among other things, the retina is not as widely sensitive to red and green as to blue and yellow (Plate 7) and why some people who see blue and yellow have defective red and green sensitivity (Plate 8).<sup>6</sup>

Before leaving the topic of visual reception it should be noted that, whereas the cones cease to function under low illumination, the sensitivity of the rods increases under such conditions. This is the well-known phenomenon of *dark-adaptation*. Indeed the sensitivity of the eye becomes possibly as much as a hundred thousand times greater in complete dark-adaptation than in light-adaptation. This increased sensitivity to light is due to changes which take place in the rods. That dark-adaptation is a function of the rods rather than the brain is shown by the fact that one eye can be dark-adapted while the other is being light-adapted.

While the eye is in darkness there is increasing concentration of a photochemical substance in the rods. Because it has a purplish color, this substance is referred to as *visual purple*.

People who do not readily become dark-adapted are relatively blind under conditions of low illumination such as exist at night. They are said to be *night blind*.

## AUDITORY RECEPTION

Waves set up by vibrating bodies are transmitted through air to the eardrum. In the ear they arouse certain mechanical activities which stimulate nerve fibers. When the impulses thus elicited get to the brain, we hear.

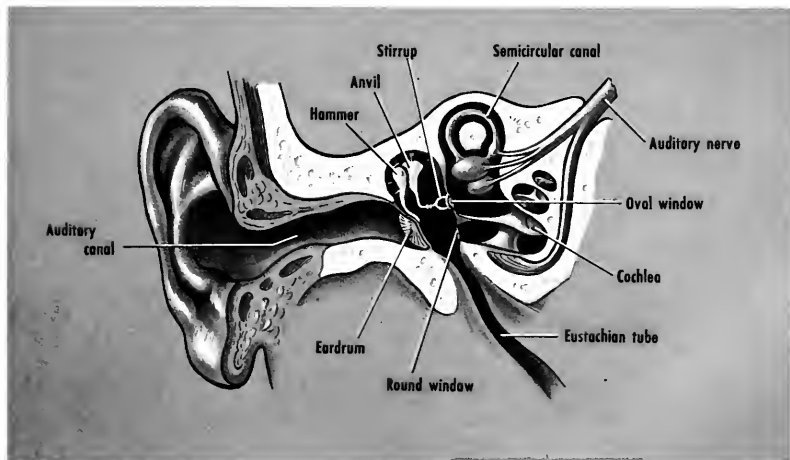
The *pitch* of a sound is determined primarily by the *frequency* of air waves, that is the number of waves per second. Thus the note middle C is correlated with a frequency of 256 cycles per second. Lower frequencies produce tones of lower pitch; higher frequencies, tones of higher pitch. Observe in Figure 13.15 that frequencies toward which the human ear is attuned range between approximately 20 and 20,000 cycles per second and also that our ear is most sensitive to frequencies between 2000 and 5000 cycles per second. This means that sound waves within this frequency range need less intensity (sound pressure) to make them audible than do waves of higher and lower frequency. The *loudness* of a sound is a function primarily of the sound pressure that activates the eardrum. This is correlated with the *amplitude* of the sound wave, i.e., the

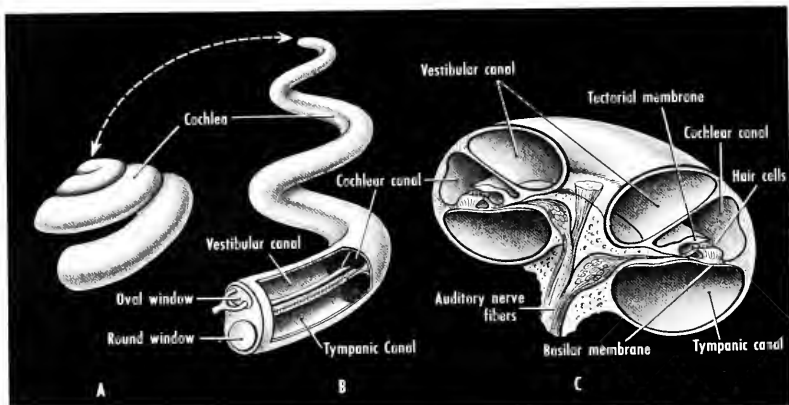
degree of displacement of the vibrating body from the resting position. Think, for instance, of the maximum displacement of a tuning fork prong or vibrating harp string. Vibrating bodies usually vibrate complexly. The harp string, for example, vibrates as a whole, in thirds, in fourths, and so on, all at the same time. The *complexity* thus involved determines the *timbre* or quality of a sound. Thus a harp and a horn playing the same note sound different. What we have been discussing is *tone*. This is correlated, as we have seen, with periodically vibrating stimulation. Aperiodic vibrations, those without periodicity, give rise to *noise* rather than tone.

Before we can hear, sound waves must activate the ear mechanisms and give rise to nerve impulses which travel to the cerebral cortex. For this reason, psychologists study the structures and functions of the ear itself as well as the auditory pathways and their interconnections with various brain structures.

The gross anatomy of the ear is illustrated in Figure 13.16, which also shows the semicircular canals and the vestibular branch of the auditory nerve, neither of which has anything

**13.16** A Diagrammatic Cross Section of the Human Ear. Observe that the auditory nerve has two branches. One of these, the vestibular, connects with the semicircular canals and serves the static (equilibratory) sense. The other branch, the cochlear, is auditory in function.





**13.17 The Cochlea.** A, the cochlea, coiled as it is in position in the inner ear. B, the cochlea partly extended and sectioned to show the internal structure. C, the cochlea in cross section, showing the organ of Corti, and hair cells.

to do with hearing. We will consider the latter structures when the static sense is discussed.

Sound waves travel through the external canal until they strike the *tympanic membrane* (eardrum). Vibration of this membrane activates the attached *hammer* and, through it, the *anvil* and *stirrup*. Attached to the hammer is the *tensor tympani*, a muscle that adjusts the hammer and tympanic membrane for different intensities in such a manner as to prevent injury to the latter. The stirrup, which also has a muscular attachment (not shown) presses against the *oval window*. Its movements press the membranous window in and out. Movements of the oval window cause waves to travel up the *vestibular canal* and back down the *tympanic canal* of the cochlea. Both canals are filled with liquid. A push of the stirrup is compensated for by an outward bulge of the round window, which appears at the lower extremity of the tympanic canal. Withdrawal of the stirrup causes an inward bulge of the round window.

What we have here is actually a single long liquid-filled canal which ascends, then descends. This is illustrated in Figure 13.17, A

and B. In B the cochlea is represented as uncoiled. The place at which the canal reverses its direction is the *helicotrema*, situated at the apex of the cochlea. The entire structure is coiled in the form of a spiral with two and one half turns.

Separating the two large canals of the cochlea is a ledge of bone and other tissue. It contains two thin membranes which enclose a small channel known as the *cochlear canal*. It is in this that the true auditory receptors are located.

A cross section of the uncoiled cochlea is represented in Figure 13.17, C. Here we see the relation of the three canals to each other. The cochlear canal is separated from the vestibular by *Reissner's membrane*, and from the tympanic by the *basilar membrane*. On the basilar membrane is the *organ of Corti*, the hair cells of which project up into the liquid which fills the canal. These cells connect with nerve fibers which run along the center of the cochlea and then out into the cochlear branch of the auditory nerve. The *tectorial membrane* is above the hairs, whose upper ends project into it.



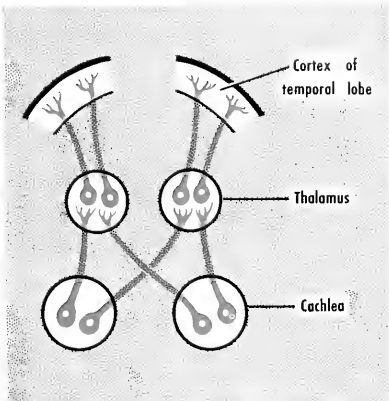
The basilar membrane is set in motion whenever a disturbance occurs in the ascending (vestibular) and descending (tympanic) canals. This motion has been characterized as a traveling wave or bulge. Different portions of the basilar membrane are apparently attuned to different frequencies, so that, when a given frequency activates the ear, the corresponding part is bulged to a great degree than other parts.<sup>7</sup>

The basilar membrane itself is a harp-like structure with fibers ranging in length from short to long. Fibers are shortest at the base of the cochlea, where most of the bulk is merely connective tissue. They become progressively longer as the apex (which has very little connective tissue) is approached. The region containing short fibers is near the stirrup, i.e., at the base of the cochlea. This is the place of a maximal response to high frequencies. The part of the cochlea containing the longest fibers is, as we said, near the apex (the helicotrema). This portion responds maximally to low frequencies.

Activity of the basilar membrane moves the organ of Corti, the hair cells of which are induced to bend. This bending excites the ends of nerve fibers associated with the hairs. Hair cells are activated to the greatest degree, presumably, in the region of the basilar membrane in which maximal disturbance is taking place.

Nerve impulses aroused by the hair cells of Corti travel to the thalamus (see Figure 13.18), where synaptic connections with fibers running to the temporal lobe of the cerebrum are made. Each ear is connected with both sides of the cortex. Thus, loss of one temporal lobe does not produce complete deafness in either ear. Loss of both temporal lobes in man produces complete deafness. Some animals, however, continue to respond to noise after the entire cerebrum has been removed. In such instances it is apparent that the thalamic connections are sufficient for response to noise.<sup>8</sup>

Theories of hearing attempt to fit together the facts of auditory experience on the one hand, and what is known about the structures and functions of the auditory mechanisms on the other. They are particularly concerned with the physiological events which intervene from the moment the ear is stimulated until the moment we hear a certain pitch. Loudness,



**13.18 Schema to Show How Each Ear is Connected with the Cortex.** You can see from this diagram why injury to one temporal lobe renders neither ear completely deaf. (After C. T. Morgan.)

timbre, and other aspects of auditory experience also receive attention. However, as in the field of vision, we have several theories and there is as yet no generally accepted explanation of all the facts which an adequate theory needs to encompass. Two different yet supplementary theories are worthy of attention. These are the place and volley theories.

#### Place theory

This was presented in its original form by Helmholtz, who thought that the fibers of the basilar membrane resonate to external frequencies somewhat like wires in a piano. In its present form the place theory supposes that each region of the basilar membrane is especially attuned to a certain frequency of vibration. Thus, a particular narrow region of the basilar membrane is supposed to react maximally to a certain frequency, although other parts are also to some extent activated. Our experience of pitch would depend upon the part of the basilar membrane which gives the maximal response to a vibration frequency.

It is generally supposed, however, that impulses aroused in different regions of the basilar membrane go to different regions of the auditory area of the cerebral cortex. Thus, the cortical region affected would be the most immediate correlate of a particular pitch experience.

Although its fibers do not vibrate in the manner of wires in a harp or piano, the basilar membrane does respond differentially to different frequencies.<sup>9</sup>

There is also evidence, although somewhat conflicting, that exposure of an animal's ear to loud sounds of high pitch destroys the basal regions of the cochlea, where the short fibers — those assumed by the place theory to function for high pitch — are located. Low tones of great intensity produce widespread rather than localized damage to the basilar membrane.<sup>10</sup>

According to the place theory, loudness depends on how much of the basilar membrane is activated. Two tones of the same frequency and intensity would activate the same range of fibers. Moreover, the same particular fibers would be activated maximally. If the two tones of like frequency differed in intensity, however, the range of fibers activated would be greater in the case of the greater intensity, even though the fibers maximally activated would be the same. Thus, according to the place theory, pitch depends upon the place maximally activated, and loudness upon the spread of disturbance in either direction from the place most involved.

### Volley theory

It has been observed in research by Wever and Bray<sup>11</sup> that frequencies up to about five thousand cycles per second are somehow transmitted by the auditory nerve, even though no single fiber responds more frequently than one thousand times per second (as determined by an absolute refractory period of .001 seconds). This suggests that nerve fibers work in squads. A particular group of fibers would be discharged by one wave but not by the next. Some fibers in the group, because of their greater excitability, would discharge more often than others.<sup>12</sup>

Despite wide differences in the excitability

of different fibers in the auditory nerve, there would be a spurt of impulses involving some fibers with every wave. Thus, for a tone of three thousand cycles per second, there would be a spurt of activity in the auditory nerve every three thousandths of a second, with different groups of fibers responding each time, and some fibers, because of greater excitability, contributing to more of the spurts than others. Pitch, according to this theory, is thus dependent upon the frequency of *volleys*, not the frequency carried by the individual fibers.

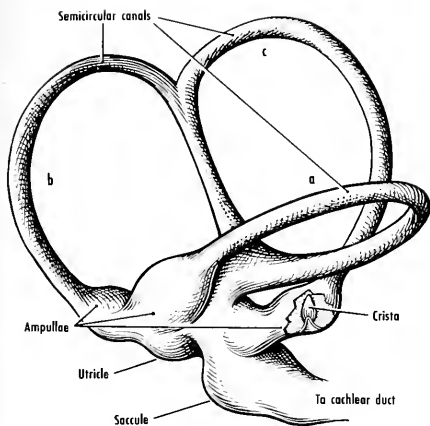
Loudness is accounted for by supposing that, with an increase in the intensity of stimulation, more impulses occur in each spurt. We have already seen that an increase in the intensity of stimulation causes more nerve fibers to respond and also leads to a more frequent response in each fiber. Thus, a wave of increased amplitude might activate one hundred instead of fifty fibers; and fibers which had been responding only five hundred times per second might now respond seven hundred times per second. The total effect would be to produce more impulses per volley, without changing the frequency, or temporal distance, of the separate volleys.

At the present time it seems apparent that both the volley and place principles are involved in hearing, with the volley factor playing a major role in mediating frequencies up to around five thousand cycles and the place factor a major role in mediating higher frequencies. Although there is much to be learned about how these principles operate, especially in producing complexities of hearing, both appear necessary.<sup>13</sup>

### STATIC SENSITIVITY

If stimulation of all other senses were eliminated, static sensitivity would still make it possible for us to know whether we were right side up or upside down, falling or going up, spinning or standing still, moving forward or backward, or to right or left.

The receptors which mediate static sensitivity are in the nonauditory labyrinth, which, as illustrated in Figure 13.19, comprises three semicircular canals and two small sac-like chambers (sacculi and utricle), known jointly as the vestibule. The relation of these struc-



**13.19 The Nonauditory Labyrinth.** The entire labyrinth is filled with a liquid known as the endolymph. Its relation to the auditory mechanisms may be seen by referring to Figure 13.16.

tures to the cochlea and other parts of the ear was shown in Figure 13.16 (p. 379). A liquid known as *endolymph* fills the canals and vestibule.

Each semicircular canal is almost at right angles to the others. There is one canal corresponding to each of the three planes of space. Turning the head in a clockwise or counterclockwise direction activates canal *a*. Canal *b* is activated when the head tips in a forward-backward direction. The remaining canal, *c*, is activated by tilting the head in a right-left direction.

At the base of each semicircular canal is a swelling (*ampulla*) into which a small structure containing hairs projects. The hairs of the *crista*, as this structure is called, are bent by a rotary movement of the head. Their bending stimulates associated nerve fibers, which carry impulses thus aroused over the vestibular branch of the auditory nerve (Fig. 13.16) to the brain.

The hairs are activated only by changes in rotary movement. As one suddenly turns his

head to the right, the liquid in canal *a* lags, causing the hairs to move to the left, or vice versa. As one suddenly tilts his head forward, the hairs in canal *b* are bent in an upward direction, or vice versa. As one tilts his head to the right, the hairs in canal *c* are bent to the left, or vice versa.

The vestibule, at the base of the semicircular canals, is activated primarily by rectilinear motion—that is to say, motion straight up and down, straight forward or back, or straight to the right or left. One form of rectilinear movement is experienced whenever we go up and down in an elevator.

Sensitivity to rectilinear movement results from the bending of hairs in the saccule and utricle of the vestibule. These hairs are weighted with calcium particles (*otoliths*). Movement of the body in an up-down, front-back, or right-left direction is associated with a lag in adjustment of otoliths, hence a bending of hairs in the opposite direction. Nerve impulses are aroused which, like those from the semicircular canals, go to the brain via the vestibular branch of the auditory nerve.

Under most conditions of everyday life, our semicircular canals and vestibules are stimulated simultaneously. Impulses which come from the separate structures are coordinated in the cerebellum. They play a major role in maintaining the tonus of muscles and the equilibrium of the whole body.

## KINESTHESIS

Any normal individual with eyes closed can touch his nose, ear, or any part of his body with a high degree of accuracy. He can move his limbs in various ways and know their position from moment to moment. He can, by lifting them, discern the relative weight of objects. He can go directly to the familiar light switch in complete darkness, walk along the street without paying attention to what his legs are doing, carry on a conversation without thinking of the muscular movements involved, and, if he is an experienced aviator, fly “with the seat of his pants,” giving no attention to the manipulation of controls. Likewise, the typist types without looking at or thinking of her fingers, the knitter knits without looking at her knitting needles,

and so on. Many of these movements are carried out in the most automatic and stereotyped manner.

The automaticity of such behavior and its independence of vision are made possible by receptors in the muscles, tendons, and joints.

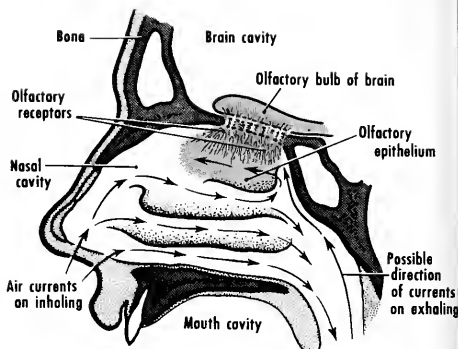
The kinesthetic receptors are subjected to pressure, or release of pressure, as our muscles, tendons, and joints are moved. As a consequence, nerve impulses are sent to the brain, providing information concerning the position of our limbs. Other impulses are sent back to the muscles, tendons, and joints, thus stimulating further activity. Through this feedback mechanism, motor activities act as stimuli for their own rearousal, or for the arousal of other motor activity. This is why kinesthetically controlled habits can proceed so automatically.

Few people realize their dependence on kinesthesia unless they are afflicted with *tabes dorsalis* or observe others so afflicted. This disease (sometimes caused by syphilis) follows destruction of tracts which carry impulses from our kinesthetic receptors to the brain. When these tracts (Plate 2, tracts for muscle sense) are disrupted at any level, all kinesthetic sensitivity below that level is, in effect, destroyed. Impulses come into the spinal cord as before, but they now have no pathway to the brain. The individual thus affected sways considerably when his eyes are closed, cannot lift his foot onto the curb without looking at it, walks with a peculiar (tabetic) gait, and if the destruction is high in the cord, cannot touch his nose or ear with his eyes closed without extensive exploration.

#### OLFACTORY SENSITIVITY

The sense of smell is very important in the adjustment of many lower animals. It might be of greater importance in everyday human life than it actually is but for the fact that our visual and auditory senses serve us so well.

Although unimportant as compared with vision and audition, olfactory sensitivity plays a more or less subtle part in many of our experiences and activities. The "taste" of substances is largely smell. Olfaction puts us on guard when foodstuffs are unfit to eat. When food smells good, on the other hand, we eat it with increased relish.



**13.20** A Cross Section of the Nose. The olfactory receptors are shown in blue.

The olfactory receptors are long thread-like structures leading from the *olfactory bulbs* down into a small area at the extreme top of the nasal cavities. At their lower end, on which small hairs or cilia appear, the olfactory cells are embedded in the *olfactory epithelium*. Figure 13.20 shows the location of these structures and their relation to the olfactory bulbs. It also shows that the olfactory epithelium is above the main current of air going from nostrils to lungs. Only eddy currents reach the receptors. This is why sniffing is helpful in identifying an odor.

Nerve fibers run from the olfactory bulb into a highly complicated network of neurons. This network is linked by other fibers to various centers in the brain.

#### TASTE SENSITIVITY

That the "taste" of familiar substances is, in reality, smell is easily demonstrated. With his nostrils blocked to prevent air from reaching the olfactory receptors, a subject has little or no success in recognizing substances placed on his tongue. Place a drop of lemon juice on his tongue, and he says merely that it is "something sour." A drop of Coca-Cola may elicit the response "bittersweet." Quinine is identified merely as bitter. As soon as the nostrils are opened, however, lemon juice is

identified as lemon juice, a cola drink as such, and quinine as quinine.

Experiments have shown that there are actually but four fundamentally different tastes. These are salt, sour, sweet, and bitter. All true tastes are either salt, sour, sweet, bitter, or combinations of these.

Although taste and smell are the primary contributors to what commonly passes as "taste," other senses sometimes play an important role. The characteristic "feel" of a substance in the mouth may be important. Some substances (like chili and mustard) actually arouse experiences of prick or burn, suggesting that common chemical sensitivity is activated. Other substances merely feel smooth or rough, suggesting cutaneous involvement. It is well known, furthermore, that certain substances "taste" quite different at different temperatures. There is a marked difference, for example, between cold and hot coffee and cold and warm Coca-Cola.

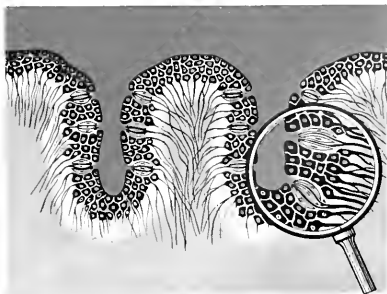
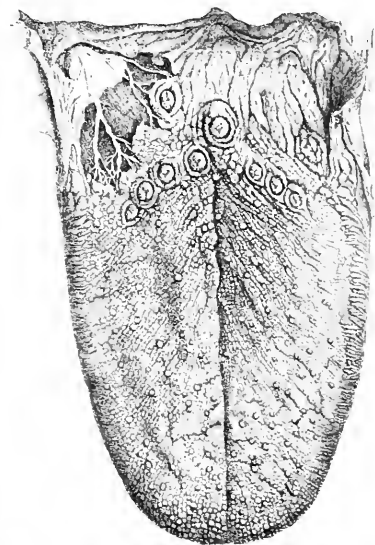
The tongue has a number of slight elevations (papillae), the most evident of which are those alligned in the form of a chevron toward the back (Figure 13.21). These, the *circumvallate papillae*, contain taste cells especially sensitive to bitter. The *fungiform papillae*, evident along the sides and tip of the tongue, also contain taste cells. Those at the tip of the tongue are especially sensitive to sweet, those at the sides to sour, while others scattered all over the tongue except at the center are sensitive to salt. The central part of the tongue toward the front is not sensitive to any gustatory stimuli.

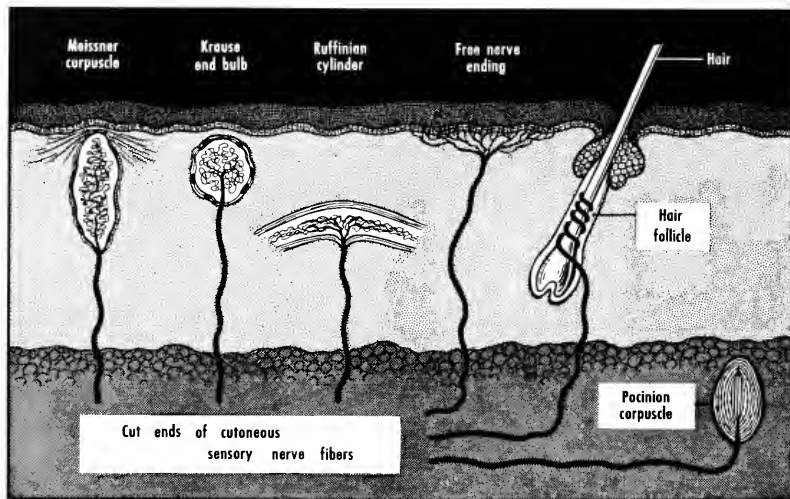
The taste receptors proper are in *taste buds* at the sides of the circumvallate and fungiform papillae. These buds, because of the peculiar arrangement of their taste cells, were once referred to as "taste onions." The location of taste buds within the circumvallate papillae is also illustrated in Figure 13.21. This drawing gives some idea of the structure of the taste cells and their neural connections. Each of the papillae contains several taste buds, and each of these has several taste cells. We can now see why substances must be in liquid form to stimulate the taste receptors. They must get into the cervixes of the papillae, seep into the pore of a taste bud, and then reach the taste cells.

Nerve fibers at the base of the taste cells

carry impulses (over the nerves shown in Figure 13.21) to the brain.

**13.21 Taste Receptors.** The nerve shown at the upper left goes to the brain. The larger circular-appearing cells near the top of the tongue, shown in greater detail in the cross section drawing, are the circumvallate papillae. Note that each taste cell has its own nerve fiber, but only one in each taste bud is thus represented here. Each bud also has many more cells than can be shown in the diagram. (Drawing from Warren and Carmichael, after Wenzel.)





**13.22 Diagrammatic Representation of Some Cutaneous Structures.** Meissner's corpuscles, some free nerve endings, dendrites around hair follicles, and Pacinian corpuscles all respond to pressure, but the latter only to heavy pressure. Other free nerve endings mediate pain sensitivity. The function of the Krause end bulbs and Ruffinian cylinders, once thought to mediate, respectively, cold and warmth sensitivity, is not known. (Modified from Warren and Carmichael.)

### ORGANIC SENSITIVITY

Organic sensitivity is sensitivity of the visceral and other internal organs of the body cavity. The viscera include the stomach, intestines, internal sex structures, and kidneys. Nonvisceral inner structures are the throat, lungs and heart. Activities of the internal organs excite sensory fibers, sending nerve impulses into the central nervous system. Reception of these impulses in the brain underlies organic sensitivity.

Many experiences, most of them rather vague, are associated with the activity of internal structures. Some of these are thirst, hunger, nausea, bladder and intestinal tensions, sexual cravings and thrills, suffocation, and the feeling of fullness. In several instances these feelings have been reduced to

varieties of pressure, pain, and temperature sensitivity. Thirst, for example, is associated with dryness in the throat; hunger is associated with pressures and pains resulting from stomach contractions; and nausea is reducible to aches and pains as well as dizziness.

### THE SKIN SENSES

All complex cutaneous experiences, such as itch, burn, roughness, smoothness, stickiness, wetness, and vibration, are reducible to one or more of the following: cold, warm, pain, and pressure. It is now generally accepted that these four are primary skin experiences.

Free nerve endings (Figure 13.22) are almost everywhere on the body and some of these appear to mediate pain sensitivity. The mucous lining of the cheek, which has no free

nerve endings, fails to yield pain. Hair follicles and associated nerve fibers, appearing to the "windward" side of hairs, where points which respond to pressure are located, are apparently pressure receptors. Meissner's corpuscles, sometimes referred to in physiology books as "touch corpuscles," are thought to mediate light pressure in hairless regions. Some free nerve endings also respond to pressure. These endings are believed to differ from those which mediate pain in that their fibers are thicker and carry impulses at a greater velocity. Heavy pressure stimulates the subcutaneous tissues, where Pacinian corpuscles are found. These are thus assumed to be receptors for heavy pressure.

The structural correlates of temperature sensitivity are not known. Encapsulated end organs lying deep in the skin, free nerve endings, and the microscopic blood vessels (capillaries) which run to every part of the skin, have each been mentioned as possible temperature receptors.

Krause end bulbs were once thought to be the sole receptors for cold, and Ruffinian cylinders the sole receptors for warm. But psychologists located points which responded to cold and warm, and had them cut out and sectioned histologically — only to find neither Krause end bulbs nor Ruffinian cylinders. Free nerve endings alone were found.<sup>14</sup>

## Summary

All that we know of the world around us and about our own body comes from the decoding by the brain of messages carried to it from receptors by impulses traveling over nerve fibers. The messages are initiated by sensory stimuli — light waves, air vibrations, mechanical pressures and chemical properties of the environment. Basically, the messages carried by nerve fibers are all alike. This is because all that the stimulus does is to release energy already in the fibers. When it responds at all, a nerve fiber responds completely. Because of this all-or-none response, the only way in which a message may be coded is in terms of an impulse's: (1) place of origin — the receptor stimulated — and (2) its destination in the brain. Thus an impulse from a visual receptor always goes to a particular place in the cerebral cortex. An impulse from an auditory receptor, although just like one from a visual receptor, goes to a different place. The brain thus decodes the message, i.e., gets the sensory information conveyed, in terms of the place activated. While impulses originating in the eyes bring information as to the visual qualities of an object and those originating in the ears bring information concerning its sound qualities, a succession, or combination of such impulses, brings additional information.

We have seen that a more intense stimulus does two things: (1) it increases the number of

impulses per second (the frequency of the nerve impulse) and (2) it activates more fibers at the same time. Thus the presence of an increased intensity of stimulation is encoded in terms of the frequency and number of nerve impulses aroused. The brain reacts to these messages in such a manner as to make us aware of differences in brightness, loudness, pressure, and so on.

The unit of the nervous system is the neuron — a cell body with dendrites (carrying impulses toward it) and axons (carrying impulses away from it). There are three basic neuron types — afferent (sensory), efferent (motor), and connector (association). Afferent neurons have an input function. That is, they pick up messages from the receptors and convey them into the central nervous system (spinal cord and brain). Efferent neurons convey impulses from the central nervous system into effectors (muscles and glands). The links between afferent and efferent neurons, including all interconnections within the central nervous system, involve connector or association neurons. The place where an impulse passes from one neuron to another is the synapse. Nerve fibers are the dendrites and axons of neurons. A nerve is a bundle of such fibers.

Once activated, a nerve fiber is refractory (nonexcitable) for a brief period. This is the absolute refractory phase. No matter how in-

tense the stimulus may be, there is no response. Then the nerve fiber begins to recover its excitability (relative refractory phase). Now a relatively intense stimulus may excite the fiber. Because it excites a fiber during the relative refractory period, a strong stimulus can be effective more often than a weaker one. This is why, as already indicated, a stronger stimulus produces a greater frequency of nerve impulses than a weaker one.

After entering the spinal cord, each impulse may travel over connector (association) neurons to an efferent neuron and out again, where muscle cells are activated. But impulses are not confined to such channels (reflex arcs.) Some ascend the spinal cord, making further connections in the brain stem, cerebellum, and cerebrum. On their way to the thalamus through the brain stem, nerve fibers give off side branches which enter an elongated mass of cells within the brain stem which are known, collectively, as the reticular formation. Impulses entering the reticular formation activate it, with the result that a diffuse discharge occurs. This spreads to the cerebral cortex and alerts it for the reception of sensory information coming over the ascending columns of the spinal cord and the cranial nerves. The thalamus is a switchboard mechanism which relays impulses to the various specialized sensory areas of the cerebral cortex. The visual area is in the occipital lobe, the auditory is in the temporal lobe, and the somesthetic is in the parietal lobe. The remaining lobe, the frontal, has no known sensory functions. It includes the motor cortex (where voluntary motor activities are initiated) and a large association area which appears to play an important role in higher activities like thinking and reasoning. The parietal, temporal, and occipital lobes also have associative functions, especially those relating to the senses represented by them.

What we see is dependent upon (1) the light transmitted to our eyes, (2) the physiological and neural reactions of the eye and cortex to light which falls upon the retina, and (3) our interpretation of these reactions, which of course involves nonvisual as well as visual regions of the brain.

Chromatic vision varies in *hue* and *saturation*, as well as in brightness. Hue is what we commonly call "color," for example, red and

green. It is correlated closely with the wave length of light. Saturation refers to the amount of color. Brightness, an intensive aspect of light, is correlated with wave amplitude.

Our eye is in some respects comparable to a camera. Both focus an image on a photosensitive surface. In the case of the eye, this is the retina with its photosensitive receptors, the rods and cones. When the rods and cones are activated, nerve impulses pass across the bipolar neurons, on to the optic ganglia, and then along the optic nerve. When they reach the thalamus they are relayed to the visual cortex (in the occipital lobe). One half of the fibers of each optic nerve cross (in the optic chiasma) to the other side. Fibers from the right half of each eye go to the right occipital cortex. Likewise, those from the left half of each eye terminate in the left occipital cortex. Brightness depends upon the number of nerve fibers activated by a stimulus and the frequency of discharge in these. Experiences of hue depend upon activation of cones. Different kinds of neurons carry similar impulses (all-or-nothing law), hence differences in hue must depend upon the place in the occipital cortex where impulses from different kinds of cones terminate, as well as interaction at this level, as when red at one eye and green at the other produces an experience of yellow.

Animals without cones are color blind. The most common type of human color blindness involves difficulty in discriminating red and green.

The central (foveal) region of the retina is sensitive to all hues and there is a peripheral region sensitive only to blue and yellow. Vision outside of the blue-yellow zone is achromatic. Because cones cease to function under very low illumination, and the fovea has only cones, it is blind under twilight conditions.

One theory of color vision is based upon the idea that there are three kinds of cones maximally sensitive to, respectively, the blue, green and red regions of the spectrum. Yellow is assumed to depend upon an interaction of the red and green processes. There are other theories and the issue of how we see color is still under discussion.

Rods mediate achromatic vision and make vision under conditions of low illumination possible. They contain a light-sensitive substance (visual purple) which bleaches when



exposed to light and which recovers in darkness.

The chief facts about audition are these: pitch is correlated with the frequency of sound waves, loudness with their amplitude, and timbre with their complexity. Noise differs from tone in that the sound waves correlated with noise are relatively lacking in periodicity. The range of frequencies to which human ears are attuned is from about twenty to twenty thousand cycles per second.

Sound waves carried to the eardrum make it vibrate. Vibration is carried to the oval window of the cochlea by three small bones in the middle ear. As the oval window of the cochlea vibrates, liquid in the two outer canals is set in motion. This motion causes a bulge to travel up and down the basilar membrane, the lower part of the middle (or cochlear) canal. Movement of the basilar membrane causes small hairs in the structures above it to bend. Nerve impulses are aroused which travel over the auditory nerve to the brain.

The cochlea responds differentially to different frequencies, its base making a maximal response to high frequencies, and its apex a maximal response to low frequencies.

The place theory of pitch supposes that each part of the basilar membrane is so attuned that it responds maximally to only one frequency. Thus, the place in the basilar membrane maximally activated, and the place in the brain to which impulses from this maximally activated region go, would determine what pitch was heard. Loudness, according to this theory, is associated with the spread of excitation, a more intense stimulus affecting more of the basilar membrane than a weaker one. The volley theory supposes that the frequency of volleys of nerve impulses coming into the auditory cortex determines the pitch of a sound and that the number of impulses per volley determines loudness.

The present situation with respect to auditory theory is that a combination of the place and volley principles is required.

Static sensitivity comes from activation of our semicircular canals and vestibule by, respectively, rotary and rectilinear motions of the body.

Kinesthetic sensitivity depends upon activation of receptors in our muscles, tendons, and joints. It is of special interest that, because of these receptors, muscular activities provide the stimuli for their own rearousal or for the arousal of other muscular activities. Kinesthetic feedback underlies the automaticity of our well-established habit patterns.

Smell plays a subtle role in everyday life, especially in its contribution to what commonly passes for "taste." Olfactory receptors are located high up in the nostrils and are stimulated only by substances in gaseous form.

Taste, as such, consists of four primary qualities, namely salt, sour, sweet, and bitter. The taste receptors are small buds located in the walls of certain of the papillae of the tongue. In order to stimulate cells in the taste buds, substances must be soluble. The "taste" of many substances is largely olfactory and cutaneous.

Organic sensitivity is that associated with functioning of the internal organs. It includes hunger, thirst, sexual cravings and thrills, and bladder and intestinal tensions. Some organic sensitivity, at least, is reducible to complex patterns of pressure, pain, and temperature sensitivity.

The primary skin senses, once referred to in combination as the sense of touch, are pressure, pain, cold, and warmth. Sensitivity to light pressure is mediated by hair follicles, Meissner's corpuscles, and free nerve endings. Heavy pressure involves the deep-lying Pacinian corpuscles. Pain sensitivity is mediated by free nerve endings, those at the end of relatively thin fibers. No specialized receptors for temperature sensitivity have been located. Complex cutaneous experiences like vibration, stickiness, dryness, wetness, smoothness or roughness, and heat are due to simultaneous arousal of two or more of the primary skin senses.

(References and notes for this chapter are on page 565 of the Appendix.)

## *Selected Readings*

- Gardner, E., *Fundamentals of Neurology* (3rd Ed.). Saunders, 1958. More detail on the topics in this chapter.
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# Attending and Perceiving

14



Attending and set • Some aspects of attending • Varieties of attending • Determiners of attention • Analysis of perceiving • Set in perceiving • Past experience and meaning • Reduced cues • Context • Perceiving differences • Primitive organization in perception • Visual depth and distance • Auditory space perception • Intersensory contributions • Summary

In everyday language we speak of giving this or that situation our attention, of concentrating attention on something, and of shifting attention from one thing to another. This manner of speaking often leads to the naive assumption that attention is a faculty or power which we can turn on or off at will, or something which we lend to this or that situation. All of us use the term *attention*, and use it often. There is no good reason why we should cease. It should be realized, however, that we are referring to an act, a process, a function—not to a power or faculty. Thus, it is more correct to speak of attending than of attention, although this usage may at times be more roundabout.

Attending, from whatever angle we consider it, is in the last analysis a motivational process. You do not respond indiscriminately to every aspect of your environment, and you do not make every response that could be made in a situation. You react selectively. You respond in terms of your interests and attitudes. Sometimes, moreover, you attend “voluntarily” and sometimes “involuntarily.” Interests, attitudes, and voluntary action are topics considered within the framework of motivation. Thus, attending could also be considered from a motivational standpoint.

Perceiving, on the other hand, is a process comparable with discriminating, differen-

tiating, and observing. The term is customarily used to refer to relatively complex receptor and neural processes which underlie our awareness of ourselves and our world. This awareness is referred to as *perception*.

Although the term *perception* is usually restricted to aspects of experience, it has certain behavioral implications. Perception of objects, situations, and relationships is often correlated with particular overt reactions. If we are aware of a difference in the color of apples, we will very likely select the red ones for eating. If we see the detour leading off to the right, we will very likely take it. If we do not see it, we are likely to continue and be forced to turn back later. Perceiving that a package is especially heavy, we use both hands to lift it; otherwise we use one hand. In general, when we perceive a difference between objects, we behave differently toward each of them, and when we do not perceive a difference, we fail to exhibit differential behavior.

Much of our information about perceptual processes is obtained from differential behavior and without direct reference to experiential aspects. Some of this information comes from experimental investigations of animal and infant behavior. Animals and infants can tell us nothing about their experiences, but they do respond differently to certain aspects of their environment. We can train them to approach one color and avoid another, to make one response to a triangle and a different response to a circle, and to differentiate various stimulating conditions. We can then reduce the difference between stimuli and observe the point at which discrimination no longer occurs. Differential responses thus tell us much about the stimulating properties of an organism's environment.

Certain phenomena grouped under the heading of attending and under the heading of perceiving are identical. What one psychologist discusses as fluctuation of attention, another discusses as fluctuation of perception. One psychologist asks, "How many things can we attend to at once?" while another asks, "How many things can we perceive at once?" In all such cases the end product is the same, whether considered from the aspect of attending or that of perceiving.

In certain other instances, the two processes are clearly distinguishable. Attending usually precedes perception. It anticipates, as it were, the perception to come. But attending does not, of course, guarantee that perception will follow. One may listen for the expected call that fails to come. He may look, but fail to see what he is looking for. Another difference between attending and perceiving is the fact that the former does not in itself determine the organization or meaning of perceptual experience. The same situation may be perceived differently by all who attend to it. It may be meaningful for all, but have a somewhat different meaning for each.

### ATTENDING AND SET

We are already familiar with *set* as a determining or directing factor in association and thought. It is relevant in the present context because attending may be considered a form of set. Here we use the concept of set in much the same sense as formerly, but with particular reference to receptor, muscular, or neural adjustments which contribute to, or interfere with,

perceptual or motor responses. We say that the person with his eyes focused upon something is *set* to see it. This is an example of receptor set. It is also a muscular set, for eye muscles turn the eyes toward and focus them upon the object. We say, too, that the doctor who hears the telephone during the night, but fails to hear the baby cry, is *set* to hear the telephone. His wife perhaps fails to hear the telephone, but hears the baby. We say that she is

set to hear the baby. This is an example of so-called *mental set*. The batter with his bat in position to hit the ball has a receptor set, a postural set, and probably a mental set as well.

One should recognize, however, that a given set does not always aid perception. Some sets actually interfere with this process. You may be so preoccupied with what you are writing that you fail to hear what is being said on a near-by radio. You are set for writing, but not for hearing the radio. Your set for writing is synonymous with attending to writing, but its significance is broader than this, for it actually interferes with hearing the radio. Likewise, the ventriloquist, through the antics which he makes his doll perform, gets us set to notice the doll and its mouth movements. This attentive set is so disarming that we not only seem to hear words issuing from the doll's mouth, but also fail to notice the ventriloquist's lip movements, which, while quite abbreviated, are observable if we attend to them.

Postural sets likewise facilitate some responses and interfere with others. When the boxer feints, his opponent assumes what appears to be an appropriate posture to ward off the blow, but the blow comes from a direction for which he is not prepared, hence his set in response to the feint puts him at a disadvantage. He would have been better off to parry the blow from a neutral position than from the one assumed in response to the feint.

It should be apparent, therefore, that sets may aid or hinder perception and other forms of response. Attending is set looked at from the standpoint of its contribution to the process of perceiving or acting. Consequently, we may be said to attend to some situation when our set prepares us for perception of, or makes us more ready to react to, that situation.

From the standpoint of perception, attending has aptly been called a "preperceptive attitude" — a "reaction of expectancy and exploration,"<sup>1</sup> or "an anticipatory perceptual adjustment."<sup>2</sup> This readiness to be stimulated, or to perceive, is the aspect of attending which interests us most in the present discussion.

### SOME ASPECTS OF ATTENDING

Irrespective of what its detailed neural correlates may be, there are four very evident

standpoints from which the attentive process may be viewed. *First*, it involves *receptor adjustments*. *Second*, there is a more or less general *postural adjustment*. *Third*, the attending individual is aware of *muscle tensions* or related feelings of effort, especially if the process of attending is long drawn out. *Finally*, it is characterized by an *increased clearness*, a bringing out of detail, in whatever is attended to. Some of these aspects of attending are readily observed in ourselves or in others.

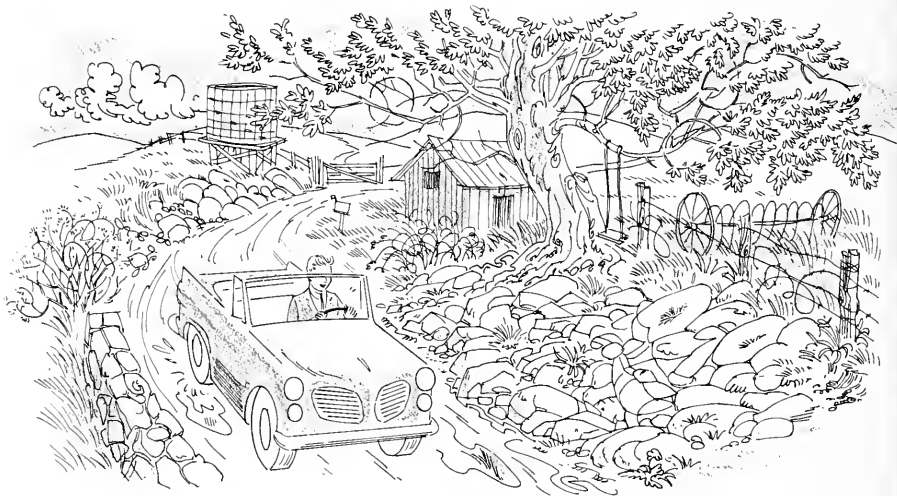
Look at the puzzle picture in Figure 14.1 and search for the hidden motorcycle policeman.<sup>3</sup> Note, before you start, that no such person is clearly, or perhaps in any way, apparent. While carrying on the search, which is obviously a process of attending, you adjust your head and eyes, there is a change in general body posture, muscle tensions are involved, and various changes take place within your nervous system. You are perhaps not aware of many such changes. When you finally discover the policeman, you will observe that he stands out from everything else. He will probably stand out so obviously that you cannot thereafter fail to see him.

Many of the adjustments involved in attending can best be observed in someone else. Ask somebody who has not already seen Figure 14.1 to search for the policeman. Note the eyes scanning the picture; note the generally alert posture; note changes in posture, or in the position of the book, so that the picture may be observed from various angles. Observe whether the muscles of the face are more tightly drawn as unsuccessful exploration continues. Quite frequently there are emotional reactions during such a search. The subject may be frustrated by inability to discover what he is looking for, and may become exasperated. On the other hand, he may become generally relaxed after discovery.

Similar receptor, postural, and emotional reactions are often observed in students when the teacher is trying to "put across" some idea not easy to grasp.

### Receptor adjustment

As already suggested, gross receptor adjustments in visual attending are readily observable. The head and eyes turn toward the



**14.1** **A Puzzle Picture.** Can you see the motorcycle policeman? Once you have seen him, his presence is obvious. If you see him immediately, try this on someone else. If you cannot find him after a good search, look at page 492.

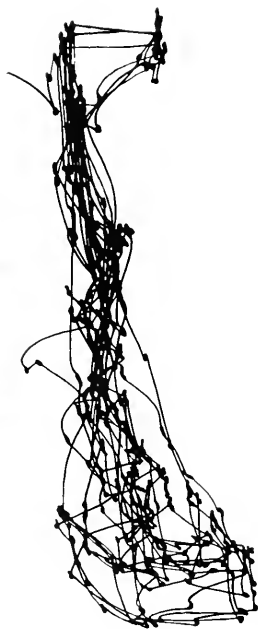
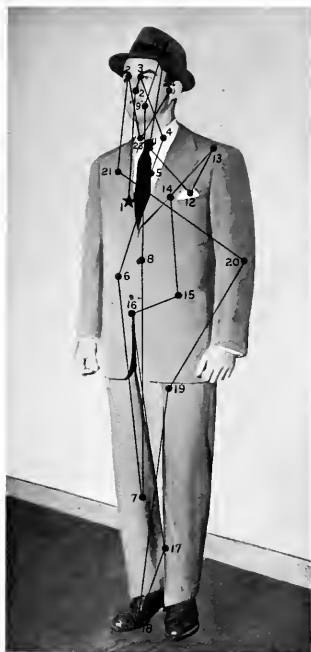
object to be observed, and there is either a continued fixation or a scanning process. Rapidly changing adjustments of head and eyes may be seen in the observers of a tennis match as the ball goes from one player to another.

Devices for photographing eye movements and the duration of fixations are often used to discover the "attention value" of different parts of a page and of different aspects of an advertisement. It is assumed that those portions which attract the eyes most often and for the longest continued fixation periods have the highest attention value.<sup>4</sup> Eye movements and successive fixations involved in a woman's scanning of a man are illustrated in Figure 14.2. This figure also shows how eye movements and fixations may actually provide a record resembling the major features of what is viewed, in this case a picture.

When the dog "pricks its ears," we have just as obvious a receptor adjustment as that of turning the head and eyes. Some animals

not only erect their ears, but also turn them in directions conducive to better reception of sound waves. The hard of hearing in former days moved their ear trumpets in a somewhat similar fashion, and for the same purpose. We cannot move our ears, but we do move our heads to facilitate reception. This is especially evident in the person who has only one good ear. He turns his head to bring it in the direction of the sound waves; he may even cup his hand behind it. A finer receptor adjustment associated with hearing involves a muscle of the middle ear (the *tensor tympani*). This muscle produces a change in the tension of the eardrum to adjust it for sounds with different intensities. The adjustment apparently protects the ear from being injured by low tones of great intensity.<sup>5</sup>

Changing the position of the nose and sniffing are obvious receptor adjustments. Touching a substance with the tip of the tongue and moving it around in the mouth so that it falls



**14.2 Plotting of Eye Movements.** An eye-movement camera was used here to photograph the location, duration, and sequence of a woman's fixations as she looked at a man. The dots indicate fixations, numbered in order of occurrence. First the woman fixated the man's chest, then her eyes swept to his face, from there to his left eye, then to his collar, etc. Data for a group of 98 women whose eye movements were studied in the same way showed that fixations on the face predominated (32 per cent of the total fixation time). Fixations on the collar and tie came next (22 per cent). (Courtesy the copyright owners, Marshall Field & Company, and LOOK. For the method used, see Brandt, 4.) The photograph at the right was made by reflecting a beam of light from one eyeball onto sensitized paper. It shows how normal eye movements trace the general pattern of the subject being observed. In this case the subject is the silhouette drawing shown above. (Courtesy Professor A. L. Yorbus, USSR Academy of Science and Scope Weekly, Physicians News Service, Inc.)

near the tip, back, or side are likewise receptor adjustments.

#### **Postural adjustment**

This form of adjustment is especially evident when one stoops, as in looking at something on the ground, when one crouches on the starting line, and when one strains forward in his seat. Attentive postures may be continued for long

periods without tiring the person, so long as what he is attending to is inherently interesting. The dog pointing and the cat with its paw in position to catch a mouse about to emerge from a hole are good examples of attentive posture. Consider, too, as a human example, the soldier standing at attention.

### **Muscle tension**

This is involved in any postural adjustment, but it is at times more subtle than general observation would indicate. For example, when efforts are made to distract subjects working at (attending to) a task, the expected decrease in efficiency often fails to appear. But frequently there is clear evidence of increased attention to compensate for the distraction. Associated with this compensatory process is increased energy expenditure, some of which is attributable to heightened muscle tension.

Six subjects were given a task in which they were required to press appropriate keys as each of a series of letters was exposed. There were ten keys, somewhat comparable to the keys of a typewriter. These were numbered from 1 to 10. The letters exposed were L M N P S T V X Y Z. They were exposed upon red, yellow, or green backgrounds. As a letter appeared, the subject was required to look at it, note the color of the background, look at a code just below, translate the letter (in accordance with the code) to one of the first ten letters of the alphabet, then press the key whose number corresponded to the number of that letter of the alphabet. Pressure brought automatic exposure of a new letter. Unknown to the subjects, there was attached to each key a device through which the amount of pressure exerted could be recorded. The aim of the experiment was to see whether the amount of pressure would change when attempts were made to distract the subject by introducing noise. The average pressure exerted under conditions of quiet was tested, both before and after noise had been introduced. This pressure under conditions of quiet was compared with the average pressure during noise.

All six subjects exerted more pressure under noise conditions than under conditions of quiet. The average pressure exerted just before noise was introduced was 305 grams. Under noise

conditions it rose to 438 grams. In a period of quiet which followed noise, the average pressure was 292 grams. The amount of work accomplished did not differ significantly under conditions of noise and quiet. Heightened attention to the task, with which the muscular exertion was associated, apparently compensated for the distracting influence of noise.<sup>6</sup>

Another example of muscular tension during the act of attending comes from an experiment in which the thickening of each of four muscle groups was measured while (1) the subjects were listening for a click known to be barely audible, and (2) they were listening for a click known to be quite obviously audible.<sup>7</sup> Subjects were required to press a key as soon as the sound was heard. They attended more closely while expecting the weaker than while expecting the louder sound. Concomitant with this additional effort was a greater thickening of the muscles whose tension was recorded.

Muscle tensions are involved in the act of attending in yet another way. When one has been asked to attend to something, and especially when he has been asked to attend to a variety of specified details, he is likely to repeat the instructions, either aloud or silently. Even when he repeats them silently, his tongue, throat muscles, and perhaps other muscles of his body are thrown into action.

### **Attending and clearness of perception**

As we have already pointed out, attending to some aspect of the environment or to some bodily process is followed by a clearer perception than previously existed. Part of this increased clearness, this bringing-out of details, is due to receptor adjustment. While reading these words, you are only vaguely, if at all, aware of your surroundings. But suppose you now attend to a piece of furniture in front of or to the side of you. Its image may have been falling upon your eye while you were reading, but it either elicited no conscious reaction or, at best, only a vague perception. Now, if you fixate upon it, the lens of your eye adjusts so as to bring it into better focus on your retina. This makes it clear and its details distinct.

Although receptor adjustment plays a part in clarifying perception, it is not solely respon-



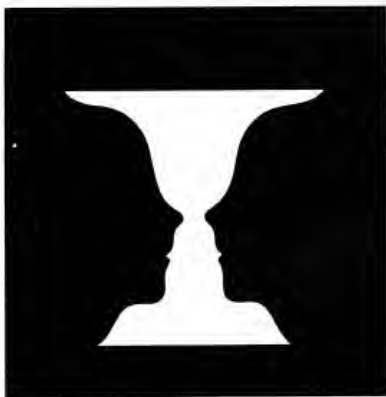
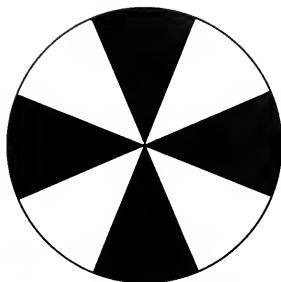
sible. One may have a perfectly clear retinal image, yet — especially if he is preoccupied with his thoughts — fail to have a corresponding visual perception.

Postural adjustments and muscle tensions also fail to tell the whole story. The student in a classroom may be in a posture of rapt attention, but, when called upon by the teacher to recite on what has just been said, he may reveal that his thoughts have been far away from the classroom situation.

### INDEPENDENT CENTRAL CONTROL

The receptor and postural adjustments so far considered are largely peripheral (or surface) phenomena, even though they must also involve central nervous mechanisms, of which, as we have seen, the reticular formation and the cerebral cortex are probably of special importance. The reticular formation (Figure 13.9, p. 372) is apparently under the control of external stimuli or of impulses reaching it from the cerebral cortex. Is the cerebral cortex, on the other hand, ever an independently acting structure? That is to say, can it produce and sustain attentive behavior in the absence of receptor and postural adjustments, which of course activate it via projection pathways and the reticular formation? There are two contrasting views on this issue. According to one of these, attending is merely a receptor and postural adjustment, the central nervous system exerting no independent control. According to the other view, the central nervous system, especially the cerebral cortex, sometimes plays an independent role in attending.

It would be easy to settle this issue if we could find some way to measure specific central neural adjustments without at the same time involving receptor and postural changes. The problem is similar to that already discussed in the chapter on thinking, where the question was raised as to whether thinking can occur in independence of peripheral activities. There we cited the case of a completely paralyzed man (p. 350) who apparently retained an awareness of what was happening around him and was still able to think. Presumably, therefore, his attentive process was operating on a purely nonmuscular basis. He was, however, subjected to visual and auditory stimulation, hence could not serve as a case in point



**14.3 Reversible Configurations.** If you fixate the center, or any other part of either figure, you will note that now one aspect stands out, now the other. At one moment, for example, you see the black figures as though on a white background; the next moment you see the white figures as though on a black background. The frequency of such figure-ground fluctuations can be influenced by trying to hold one as long as possible. The figure will change, despite your effort to hold it, but it will very likely change less often.

with respect to the issue now before us.

Certain perceptual phenomena suggest the possibility of an independent central attending process. Take for example, the fluctuations

which occur in hearing when the sound of a watch fades out or reappears; and in vision when a dim star seems to come and go. Reversible configurations like those in Figure 14.3 are also relevant. Some hypnotic phenomena likewise suggest the presence of centrally maintained sets either to attend or not to attend to stimulation. Thus a hypnotized subject may be rendered apparently inattentive to painful stimulation. Teeth have been pulled and operations performed under hypnosis, yet without any evidence of pain. On the other hand, if the subject is told that a pencil is a red hot object, he will express great pain as it is placed on his skin. Phenomena like these suggest some sort of central control which is independent of receptor and postural activities.

### VARIETIES OF ATTENDING

If the dividing line is not too distinctly drawn, it is possible to classify three types or varieties of attending—namely, *involuntary*, *voluntary*, and *habitual*.

When stimuli or situations force themselves upon us, as it were, whether or not we are set for their reception, attending is said to be *involuntary*. Thus a pistol shot, an intense electric shock, a sudden intense flash of light, a blow, and painful stimulation of any kind are perceived involuntarily; one might say “reflexly.”

Whenever we intentionally look or listen, attending is referred to as *voluntary*. Someone may say, “Look at this,” or, “Do you hear that?” and you may respond accordingly. You may strive to attend to an uninteresting lecture, knowing that if you fail to attend, your grade may suffer. You may go into town with the intention of buying a camera and, as you walk along the street, pay particular attention to camera displays in the store windows. These are all examples of voluntary attending.

When attending is difficult, as in listening to a lengthy and colorless discourse by a friend, it is often said that continued attention demands “will power.” There is no doubt that the feeling that one should listen, and the temptation to do, or think of, something more interesting, produce a conflict situation. Attempts to resolve the conflict bring about a feeling that great effort is being expended. This problem, it will be recalled, was considered more fully

in discussions of “will power” and initiation of action (pp. 228–229).

Each of us is more or less permanently set for reception of certain stimuli. Think, for example, of the doctor set to hear the telephone and his wife set to hear the baby. Think of the male’s readiness to notice a beautiful girl and the female’s readiness to notice a handsome male. Think of our periodically recurring interest in food and drink. Think of our readiness to perceive good in the actions of our friend and evil in the actions of our enemy. Think of the naturalist’s observation of plants and bugs which we fail to notice. Think of the attitude of alertness which characterizes a class as soon as such topics as sex, hypnotism, or mental telepathy are mentioned by the instructor. These are examples of so-called *habitual* attending or of habitual sets. Most of our acts of attending are continuing rather than abruptly assumed sets, and they are sets of which we are frequently unaware. These continuing sets stem from our motives. They are related to drives, interests, attitudes, prejudices, and aspirations.

### DETERMINERS OF ATTENTION

The preceding discussions have suggested that attending is related to external stimuli and also to conditions within the individual. These are often called the determiners of attention.

There has been a large volume of research on the attention-getting value of different aspects of external stimulation. The findings, as one can well guess, have proved extremely valuable in the field of advertising. An advertiser’s problem is to sell his product, but before he can induce you to buy it, he must call your attention to it and also to the reasons for preferring it to other products. As you turn the pages of a magazine, scan the newspaper, listen to your radio, or watch television, there are many things more interesting than observing what an advertiser has to say about his wares. Hence, he must literally force you to attend. Any advertisement which produced involuntary attention, and then caused you to hold your attentive set, would be most effective. Successful advertisers use external stimuli which will “catch your eye” or “get your ear,” and at the same time stimuli which will, as it were, tap your motives.

## External determiners

Among the important external determiners of attention are the nature, location, and novelty of the stimulating conditions.

By the nature of stimulating conditions we refer to such things as whether a picture is that of a woman, an animal, or a product to be sold. By the nature of auditory stimulation we refer to such things as a narration, singing, or orchestral music. It has been shown, among other things, that pictures attract attention more readily than words; that a picture with human beings in it tends to attract attention more than a picture of inanimate objects alone; and that some rhyming auditory passage attracts attention better than the same passage presented as a narrative.

The best location of a visual stimulus from the standpoint of attention-getting is directly in front of the eyes. Where this is not possible, there are still certain positions better than others. Research in advertising has discovered the attention value of various positions, not only within a magazine, but also on a given page. This research has utilized eye-cameras like those already mentioned.

Intensity is exemplified by a brilliantly lighted sign or the blaring of a loud-speaker. As you read this **sentence**, you can hardly escape noticing the word printed in black type. You probably noticed it as soon as you turned to the page. Here we have not only intensity, but contrast. The black letters, because of their relative intensity, stand out from surroundings. Intense odors, tastes, pressures, and pains, especially when they represent a sudden change from previous stimulation, also elicit attention.

The size of a stimulus is of obvious importance, but again contrast is an important aspect. If all of the **LETTERS** on this page were printed in capitals, the capitalized word in this sentence would have no greater attention-getting value than any other word; if all were printed in small type, the word with small type would have no advantage. Generally speaking, a large advertisement will get more attention than a small one, especially when the latter is surrounded by other material. But an extremely small advertisement in the center of a page that is otherwise blank is a strong determiner of attention.

We already know that there are certain colors which are more agreeable than others, and that advertisers make use of this fact. Reds and blues play a large part in color displays because of their agreeableness. But here again, contrast is important. The word in blue was probably noticed as soon as you turned to this page. It would not matter what the color had been. Color advertising derives some of its attention-getting value not so much from the colors or color combinations used as from the fact that, being colored, it stands out from the black and white which characterizes most of the other material in the magazine.

Other things being equal, a moving object is more attention-demanding than a stationary one. This is true for animals. Many an animal is safe from others so long as it keeps still, but as soon as it moves, it is pounced upon. The large neon signs typical of Broadway illustrate the value of moving stimuli. These also utilize a phenomenon to be considered shortly.

Repetition is a factor of great importance in drawing attention to some aspect of our environment. When a stimulus is repeated several times, we may eventually notice it, although we failed to do so at first. Despite the value of repetition in calling attention to a stimulus, continued repetition beyond a certain point may bring diminishing returns. We may eventually become so accustomed to the situation that it ceases to be noticed. Advertisers get around this by introducing change, and especially novelty.

Most of us attend to anything that is novel. Sounds, smells, and tastes to which we are accustomed may go unnoticed, where a strange sound, smell, or taste is immediately noticed. Strange animals and unusual dresses or furnishings attract attention because of their novelty. Use of novelty to attract attention is but another example of contrast. Anything that is novel derives this property through its contrast with what is customary. To put it in other terms, a familiar item in novel surroundings or a novel object in familiar surroundings is usually attention-getting.

## Internal determiners

External factors are potent to the degree that they tap, as it were, our continuing sets,

i.e., the internal determiners, which were elsewhere referred to in the discussion of habits of attention. These determiners stem from motives. If the individual is motivated by hunger, he is much more likely to notice the smell of cooking food or to see the picture of steak on a magazine page than if he has just had a good meal. The sexually deprived male is much more likely to notice females than is the sexually satiated one. Any advertisement involving a "leg show" is almost sure to get male attention. The man who is forced to play a submissive role, but would like to assume a dominant one, is prone to notice the physical-culture advertising. The person deprived of desired recognition notices the advertising headed, "They listened in amazement when I began to play." The movie fan is more likely to attend to an advertisement with the picture of a movie star than one with a picture of some other person. A student is especially attentive to any statement prefaced by such remarks as, "Don't fail to get this!" or, more pointedly, "I shall expect you to know this in the examination." Instructions such as "Find the hidden man" likewise produce a continuing set which, when it has once been engendered, is an internal determiner of attention.

Advertising agencies and others concerned with mass persuasion have recently become interested in probing unconscious motives, as revealed by projective tests and psychoanalysis, so that they can capitalize on these "internal determiners of action." This attempt to manipulate human beings by "getting at them below their level of awareness" is the subject of Vance Packard's well-known book *The Hidden Persuaders*.\*

Attending, it bears repeating, is in many

respects one process and perceiving another. Attending may or may not be followed by perception. When it is, however, the perceptual process itself demands special analysis.

## ANALYSIS OF PERCEIVING

Whether we look at perceiving from the standpoint of behavior, experience, or the response mechanisms involved, it is an extremely complex process. *Receptor functions* play a necessary and a predominant role, but other functions may also be involved. These have a variety of titles, but we shall group them under the two headings, *symbolic* and *affective*.

### Receptor processes

Perceiving is often referred to in terms of the receptor process predominantly involved. We speak of visual, auditory, olfactory, gustatory, kinesthetic, tactual, static, or organic perception. Under most conditions of everyday life, several receptor processes are simultaneously activated. We not only see objects, but we hear, and perhaps even smell them at the same time.

When perceiving is narrowed to a particular receptor process, such as vision, there is still much more to it than reception. The reception which is involved sets off in turn a complicated pattern of events which represents former stimulation. For example, the picture of a skunk (visual stimulation) may remind us (symbolic process) of how skunks smell, or give us an image (symbolic process) of the odor. That is to say, we may have more or less vivid experience of the odor, even though it is not present at the moment.

### Symbolic processes

Symbolic processes were discussed in the chapter on remembering (pp. 313-314). They are known by a variety of names. We have just suggested that being reminded of something or having an image of it are symbolic processes. What we commonly call ideas are symbolic processes.<sup>9</sup>

Our earlier discussions of remembering and thinking have pointed out that neural activities aroused by stimulation leave an engraving

\* This type of persuasion is different from that which attempts to influence the buyer by stimulating him so weakly that he is unaware of the fact that he has been stimulated. Such stimulation is below the threshold of visual perception. Another word for threshold is *limen*, hence this sort of influence is said to be *subliminal*. Actually, as recent studies have shown, the effectiveness of subliminal advertising is doubtful.<sup>8</sup> It is worthy of note, in any event, that a threshold is ordinarily determined by statistical means and that one can not always know when a presentation is slightly above or slightly below the threshold.

(p. 311) in the nervous system. This may then represent, or act as a substitute for, the original situation, activity, and experience. To take a very simple illustration, think of your mother's face. I might have said, "Get an image of your mother's face," "Imagine your mother's face," or, "Recall your mother's face"—it would amount to about the same thing. The image that you get, if you get one at all, may be faint or it may be clear. Unless you are congenitally blind, it is most likely visual. It is somewhat as if you saw the face. The important point, however, is that such an image is dependent on former stimulation when your mother (or a picture of her) was actually present. This stimulation modified your nervous system in some way, leaving an engram. Now certain stimuli may lead you to recall your mother's face. The stimulus may be a whiff of the perfume used by her, a voice like hers, sitting down to a meal such as she prepared, or the instruction, "Get an image of your mother's face." In short, anything associated in the past with your mother's face may activate the symbolic process.

Why do we refer to such processes as symbolic? Think, for a moment, of what we ordinarily mean by a symbol. It is something which represents something else. Words are symbols because they represent objects, situations, or events. They are symbols for us if we know what they represent.

Any present stimulus, then, in addition to arousing receptor functions, also serves to activate symbolic processes.

### **Affective processes**

It is generally recognized that each perceptual experience may have its affective aspects. We not only see an object and perhaps have images of former sensory stimulation, but the object impresses us as pleasant, unpleasant, or perhaps as neither. Certain forms of stimulation, like a strong electric shock or a needle prick, arouse feelings of unpleasantness, whether or not we have had former contacts with them. Sweet substances probably arouse pleasant experiences from the start. However, the pleasantness or unpleasantness aroused by the sight of a tree, the sound of a voice, or the odor of garlic depends upon our past experience. The odor of garlic, for example,

might be pleasant to those reared in its presence and unpleasant to many others.

We can best summarize the above discussion, and elaborate certain aspects, by referring to a particular perceptual experience. Let us take, for example, the perception of a meal cooking. At least three receptor processes (vision, smell, and hearing) may be involved. Light waves stimulate receptors in our eyes, odorous particles from the food stimulate receptors in our nostrils, and explosions in the fat set up sound waves which stimulate receptors in our ears. Related neural processes are aroused, and we have visual, olfactory, and auditory experiences. We are usually not aware of these experiences as separate. They are aroused simultaneously and are so interrelated (both from the standpoint of the stimulation provided and the central neural processes involved) that the experience is usually a unitary one. It is not analogous to a wall with its separate bricks. Rather, it is more closely analogous to water, with its hydrogen and oxygen not immediately evident.

In addition to receptor functions, symbolic processes are involved. The sight, sound, or odor of food may remind us of former occasions when we have eaten this food. Gustatory (taste) images are perhaps aroused. Although the tongue is not being stimulated at the moment, we vaguely "taste" the food. This is partly because what we call "taste" is to a large extent smell, but also because previous situations like the one to which we are now subjected have been followed shortly by actual gustatory stimulation.

There are also the affective and related processes. If we are hungry, the situation is pleasant. If we are seasick, on the other hand, it may be highly unpleasant. Its pleasantness or unpleasantness may be related to such organic processes as salivation, gastric secretions, and stomach activities.

Aesthetic experience may also be involved in our perception of a situation. We may perceive it as beautiful, ugly, or indifferent. These evaluations depend upon affective processes and also upon recall of past experience. In this way, they overlap the affective and symbolic functions.

Preceding discussions have shown that perception depends upon the arousal of receptor, symbolic, and affective processes. But this by

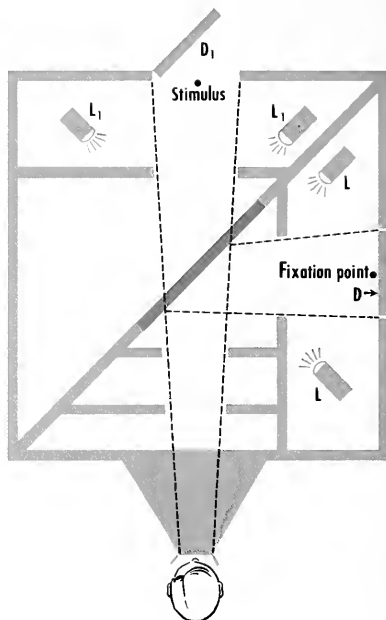
no means tells the whole story, for what we perceive is determined to a considerable extent by our attentive *set*, as earlier indicated, and also by such factors as the *context*, or general setting of the object, situation or event and our perceptual habits, our past experience with comparable situations. These contributing factors in perceiving are worthy of further attention at this stage in our discussion for they have a place in all perceptual experience, whether visual, auditory, or otherwise. Later we will focus more specifically on visual and auditory perception. At that point something will be said about aspects of perceiving which appear to be relatively independent of past experience.

### SET IN PERCEIVING

Although we have already considered attentive sets as predispositions to perceive, we have not dealt with them from the standpoint of how they can determine *what* is perceived. Sets of a relatively simple nature are aroused in the laboratory by instructing subjects so that they expect certain things to appear. How such instructional sets influence what is perceived will be considered presently. Sets of far greater complexity are those which each of us carries around with him in the form of prejudices, interests, values and other such motivational aspects of his personality. Some of these, and their influence on perception, were dealt with in earlier chapters. After considering instructional sets we will draw together relevant material that is scattered through preceding chapters, then survey briefly some related experimental investigations. These deal with perceiving as a function of motivational sets, like the personal values which an individual brings to an experimental situation.

#### Instructional sets











In laboratory experiments involving instructional sets the material to be perceived is ambiguous in that it is capable of inducing different perceptions. It is customarily presented for a very short interval—one too brief for the subject to make out all details. An instrument quite often used in such experiments is the tachistoscope, one form of which appears in Figure 14.4. The chief feature of any



**14.4 One Type of Tachistoscope.** Before exposure of the material to be perceived, the subject sees the fixation point on the diagonal lucite plate, (blue) which acts like a half-silvered mirror, when the lights *L* are on. The stimulus material is placed on the hinged door at *D*<sup>1</sup>, and this is closed. Now, as the other lights *L*<sup>1</sup> go on for the controlled exposure period, lights *L* go off, and the stimulus material is visible for the exposure period decided by the experimenter. The lamps are mercury argon tubes which have special advantages for this kind of research. This tachistoscope is a modification of earlier ones by Dodge (mirror tachistoscope). (After Merryman, J. G. and H. E. Allen, "An Improved Electronic Tachistoscope," *American Journal of Psychology*, 1953, 66, 110–114.)

tachistoscopic device is that it enables an investigator to control the exposure time with great accuracy.

In one experiment of this general nature,

different observers perceived different things, depending upon what they were led to expect.<sup>10</sup> Ambiguous figures like , , and  were exposed, one at a time, for a brief interval. After each exposure, the subject made a reproduction of what he had seen. When subjects had been told that the figure  would be like a pair of glasses, they perceived something like this: . Other subjects who saw the same figure under similar conditions, but who expected a dumbbell, drew reproductions like this: . If the subject had been told that he would see something like barbells, his drawing would probably have been more like the stimulus than it was when he was told that he would see something like glasses, or like a dumbbell. The second of the above figures was seen as  or  depending upon the expectancy that, respectively, a canoe or a kidney bean would appear. Likewise, depending upon the instructional set, the third figure was perceived as a ship's wheel () or sun ().

A certain expectancy may be built up, during the course of an experiment, yet without specific verbal instructions like those above. This expectation may also influence perception. In one such study the subjects were asked to judge which of two figures, the right or the left, constituted the more perfect geometrical design.<sup>11</sup> They had four seconds to examine each of 11 pairs. The subjects of the experimental group were shown a series in which the right-hand figure was always more symmetrical while the control group was shown a series in which either the right-hand or the left-hand figure was more symmetrical. Thus the experimental group had a set for selecting right-hand figures and the control group had no such set. The crucial test of how this difference in sets might influence perceptual judgment came when a twelfth pair was presented. This comprised a square and a rectangle, with the square on the left. Although in no way ambiguous, these figures were so slightly different that close scrutiny would be necessary in order to say which was the square, hence the more perfectly symmetrical. Interestingly enough, the experimental group, with its "right-hand set," selected the rectangle in 81.2 per cent of the judgments. The control group, with no positional set, selected this

figure in only 12.5 per cent of the judgments.

#### Motivationally determined sets

In earlier discussions we saw that such conditions as hunger and the desire to achieve may influence what individuals perceive in relatively unstructured situations. The picture on page 219 was perceived differently by those with and those without experimentally aroused achievement motivation. In discussing personality tests (pp. 245-246) we saw that a T.A.T. picture (or a Rorschach ink blot) brings different interpretations, depending upon motivational factors in the perceiver. In the ambiguous picture, for example, the person who regards his world as a threatening place will perceive signs of threat, like attackers, or "forces of evil." In the Rorschach test he may perceive bugs, or blood, or human beings "crushed by the forces of nature." The person with a different outlook will perceive none of these things.

This influence of motivational sets upon perception is by no means confined to vision. Ambiguous sounds, or sounds at too low an intensity to be perceived for what they really are, likewise arouse different interpretations, and these may also stem from differences in motivational backgrounds. The same would be true if ambiguously shaped objects were felt by different subjects.<sup>12</sup>

The reader may recall, as relevant to the above, what was said earlier (p. 346) about direction in thinking. There a man misinterpreted his wife's actions and perceived the sounds of her footsteps as signals to her lover. The motivational set was jealousy. Other emotional states may likewise influence perception, as Shakespeare recognized.

Or in the night, imagining some fear,  
How easy is a bush supposed a bear!

*Midsummer Night's Dream*

Many of our motivational sets are based upon habit and these also influence what we perceive. The entomologist, being an expert on insects, perceives organisms which completely escape our observation. Likewise, an astronomer perceives much more in the heavens than those of us with no such habitual interest, even though we, also, may be gazing at the sky through a telescope.

Social psychologists have been particularly concerned with the relation between interests, attitudes, values and other personality variables and how the individual perceives aspects of his social environment. It has been said, for example, that

perceptual readiness effects the dual requirements of coping with an environment—directedness with respect to goals and efficiency with respect to the means by which the goals can be attained. It is no matter of idle interest that a religious man picks up perceptually things that are relevant to his interest more easily and more quickly than other things, and at the same time this efficiency continues to reflect what is likely to occur in his surroundings. What it suggests is that once society has patterned a man's interests and trained him to expect what is likely in that society, it has gained a great measure of control not only on his thought processes, but also on the very material on which thought works—the experienced data of perception.<sup>13</sup>

There is no doubt that individuals develop interests, attitudes, and values which lead them to expect, and hence to perceive, aspects of their environment which others fail to perceive. They find in their environment the things that they are looking for, the sorts of things which conditioned them in the first place. By the same token, they tend to overlook, and sometimes actively avoid, aspects of the environment that are not consonant with their interests.

Despite the evidence of motivationally derived sets and their influence on perception in situations of everyday life, efforts to demonstrate them experimentally have been beset with difficulties. In one relevant experiment the subjects were first differentiated on the basis of their responses to the Allport-Vernon<sup>\*</sup> Study of Values (p. 248).<sup>14</sup> This test, as we said earlier, rates individuals in terms of their predominant values—religious, economic, scientific, political, and so on. Thus the person who scores highest with respect to the items having to do with religion is rated as “religious”; the person scoring highest on political

items is rated as “political,” and so on. Now it is quite obvious that certain words in our language are “religiously toned”—words like *sacred*, *prayer* and *reverent*. Others are “politically toned”—words such as *dominate*, *govern*, and *citizen*. What the investigators wanted to find out, therefore, was whether the “religious person,” as indicated by the test, would perceive religious words more readily than, say, the politically, economically, or scientifically toned. Accordingly such words were exposed, one at a time in mixed-up order, in a tachistoscope. A word was shown three times at an exposure duration of .01 second. If the subject failed to name it correctly, it was exposed three more times, now with a duration of .02 second. This procedure was continued, with exposure times increasing by .01 second, until the word was correctly named. Then another word was exposed. This continued until a subject had named six words each in the areas of religious, economic, aesthetic, political, scientific, and social interests. Results were in the anticipated direction. Words in the area of a subject's major interest were usually recognized sooner, i.e., with fewer exposures, than other words. But there was a serious flaw in this experiment, which other investigators were quick to point out—the fact that a person usually has a larger vocabulary in the field of his major interest than in other fields. The “religious man,” for example, knows more religious than political words. Knowing more religious words, or being more generally familiar with them, he might be expected to recognize such words for this reason, over and beyond any readiness, as such, to perceive what is religiously toned. The same principle might hold for other values. One possible solution to this methodological difficulty would be to use words which, regardless of their religious, economic, or other overtones, are equally familiar to all subjects. In an investigation involving this sort of control, the differences noted in the earlier research largely disappeared.<sup>15</sup>

One experiment in this general area seemed to demonstrate that its subjects had an unusual resistance to perceiving tabooed words such as *whore*, *bitch*, and *belly*.<sup>16</sup> When these were presented tachistoscopically, as in the above experiments, they were named more slowly than other words. But here again,

<sup>\*</sup> This was the original version of the test, now the Allport-Vernon-Lindzey Study of Values.



serious objections were raised, one of which is that tabooed words are less familiar in everyday life than other words. Hesitancy to say such words, even when they were perceived, was possibly another contributing factor.<sup>17</sup>

Long as our discussion of perceiving as a function of set has been, we have by no means mentioned every facet of this highly interesting topic. It appears, in general, that so long as one is working with relatively simple sets established in the laboratory, the results are clearly in support of the view that set influences what is perceived. Clinical data (T.A.T., Rorschach) and many observations from everyday life also support this view. But when attempts are made to subject some of man's most significant and complex sets to laboratory investigation, the variables are so complex and difficult to control that the experimental outcomes are far from clear cut.

#### PAST EXPERIENCE AND MEANING

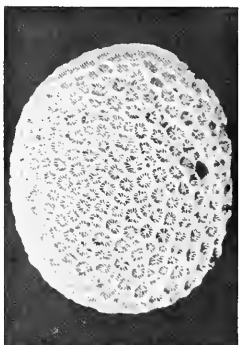
Set is largely determined by past experience. The only aspects that are not so determined are those which stem rather directly from biological motives like hunger, thirst, and sex. But past experience gives us more than a set to perceive certain things. It determines, in large measure at least, the *meaning* of what we perceive. The exceptions to this are spatial meanings associated with inborn sensory and neural structures and discussed later as "primitive organizations." These underlie aspects of visual perception. The present discussion is confined to meanings that the individual has already acquired.

The meaning of an object, situation, or event is in most instances dependent upon how it has stimulated us in the past and how we have previously reacted to it. Consider, for example, the perceptions which an apple may elicit at different stages of our perceptual development. Before we are old enough to eat an apple, one is perhaps rolled toward us in play. If this occurs sufficiently often, the apple means "something to play with." If balls have also been rolled toward us, the apple may be regarded as a ball. The apple is perhaps identifiable in terms of shape, size, weight, and color. Since all of these aspects stimulate us simultaneously, they may become associated so that any one or a combination of them arouses

symbolic processes representing the others. Thus, something with a similar color arrangement and shape (say a picture of an apple) might arouse perceptual experiences somewhat like those aroused by a real apple. After we have eaten an apple, its taste is also associated with its other characteristics. The taste not only enables us to identify the substance as apple, but also may arouse imagery representing other things previously associated with the taste of apple. Moreover, the apple now means something to eat, not merely something to play with. As we learn about Adam and Eve, drink apple cider, eat apple pie, take part in apple dunking contests, learn about apple tree swings, and have love affairs under apple trees, the object "apple" comes to have increasingly rich meaning. Any one of an apple's properties may arouse rich perceptual experience. This does not mean, of course, that we always perceive all of an object's meaning. The point is that we *may* perceive it, in terms of any experience formerly associated with it.

New situations are often fitted, as it were, into the individual's experiential background. Thus, a little girl who saw a caterpillar for the first time called it "a kitty bug." A boy whose father taught in a college building with a clock tower interpreted every other building with a clock tower as a college. Upon further contact with objects and situations, each of us modifies his interpretations. The girl learns that the "kitty bug" is a caterpillar, and the boy learns that not all buildings with clock towers are colleges.

Here are further illustrations of the fact that, in perceiving the new, we utilize our background of earlier experience. People born blind because of cataracts sometimes gain their vision during childhood or later, by having their cataracts removed. For these people, objects presented visually for the first time have very limited meaning.<sup>18</sup> A face known to the patient through touch is not recognized by sight alone. It becomes recognizable in terms of vision only after the person has both felt and looked at it. As another example, let us suppose that the person who has been blind and has merely felt the difference between a ball and a cube is shown these objects. He sees that the two objects are different but he cannot identify them as a ball and a cube until he has an op-



**14.5 How Many Objects Can You Identify?** Although the objects actually differ in size, none of them is longer, or wider, than three inches. After you have identified as many as you can, check your identifications with those on page 492 and with the identification of other students. Why do these pictures have a different meaning for different persons?

portunity both to see and feel them at the same time.

A chimpanzee reared in darkness for periods ranging from seven months to over a year, and then taken into the light, also fails to perceive visually what has been known to it through its other senses. Take, for example, the feeding bottle. The animal had held it in her hands and smelled and tasted its contents. But, when she saw it for the first time, she failed to re-

spond to it as a milk bottle. Indeed she made no response to it at all. If the bottle touched her face, however, it aroused the usual reaction to a familiar bottle. She grasped it and sucked. More than thirty feedings in the light were necessary, however, before the chimpanzee recognized the bottle visually; i. e., protruded her lips toward it when it came into view.<sup>19</sup>

The same object often has quite different meanings to different persons. Look at Figure

14.5 and see how many objects you can identify. Then compare your identifications with those of fellow students. In each instance, you, and others, receive exactly the same external stimulation, yet an object has much meaning for some and little or no meaning for others. Some objects, moreover, have different meanings for different persons, depending upon relevant past experience. Thus a psychiatrist says:

Think of your mother. If you and I see her at the same time, we certainly see very different persons. I, of course, do not know what you see; but I may see an attractive, mature woman just designed for a pleasant evening, or a fat, frowsy, old bore, or an interesting example of some obscure skin disease.<sup>20</sup>

### REDUCED CUES

As perceptual experience grows, parts of situations come to elicit the same response formerly aroused by the entire situation. This is the redintegrative process, the tendency to respond in terms of reduced cues, an aspect of which was considered in the discussion of remembering (pp. 320–321). Reading provides a good example. Our eyes fixate briefly on a word — too briefly to take in all of the details — yet we grasp the meaning of the word. This is why typographical errors like those involved in this sentence often pass unobserved, unless one is looking for them. How many were there?

Many people in our culture have little difficulty in identifying A in Figure 14.6 from the cues given. On the other hand, relatively few identify B. The reason is that few have had relevant experience with what is pictured. Only those who have observed a photographer kneeling with a graflex camera are able to see the photographer taking a picture. Even some who have had such experience have perhaps had it so infrequently that the cues provided do not arouse the appropriate perception.

We observe instances of response to reduced cues on every hand. The approach of a friend is perceived in terms of his footsteps or his voice. We recognize acquaintances on the street in terms of some obvious characteristic, or narrow group of characteristics, rather than by a careful overall scrutiny. As everyone



A



B

## 14.6 What Objects Are Here Represented?

Can you fill in the gops? See page 492. (After Street.)

knows, we sometimes “perceive” a friend, only to discover that it is not our friend at all. We have been misled, perhaps, by the stranger’s dress, her walk, her red hair, or some other aspects which she shares with our friend.

### CONTEXT

The total situation is also quite influential in determining what we perceive. Some examples of this are shown later when visual illusions are discussed. But we do not need illusions to illustrate this effect. How large is the object pictured in Figure 14.7? Make a judgment, then look at page 492 of the Appendix, where it appears in a different context. The influence of context is also evident in puzzle pictures (p. 394) and in geometrical shapes (Figure 14.8). Note, in this illustration, that the left-hand figure is concealed in each of the others. In some it is not too well concealed, but you may have difficulty in finding it in others. Camouflage often involves changes in the context of the objects which one desires to conceal.

Although we have used visual examples of context, the statement that perception is influenced by the total situation applies quite generally. When we enter a moving picture theatre in the middle of a film, it is usually difficult to perceive what is going on — to get the thread of the story — unless we know what has preceded. If we know this, then what is seen and heard at the moment takes on added meaning. It is likewise difficult to identify a piece of music, even a popular song, when one merely hears a brief portion, taken out of its context.



**14.7** **How Large is This?** After you have made your estimate, look at page 492 of the appendix. (Photo by Andreas Feininger, Courtesy Prentice-Hall.)

With the possible exception of some illusions to be described shortly, the influence of context is dependent upon past experience in perceiving. The items in our illustration are difficult to locate or identify because we have been accustomed to experiencing them in another context, or, when they occur in isolation, because we have difficulty in fitting them into the framework of past experience.



## 14.8 How Context May Conceal a Form.

Try to locate the first form in the figures at the right.  
(After Gattscholdt.)

### PERCEIVING DIFFERENCES

How much must two stimuli differ before you can notice the difference? The answer depends on several things. Small differences, unless you are set to observe them, may pass unnoticed. They are, so to speak, below the threshold of discrimination. Let us assume, however, that you are set to observe small differences. Then the answer to our question depends upon (1) the relative magnitude of the stimuli to be compared, (2) the sense stimulated, and (3) the manner in which the stimuli to be compared are presented to the subject.

If three candles are burning in a room and you add one, there will be a perceptible increase in the illumination of the room. As a matter of fact, the change will clearly be perceptible. It will be far above the threshold. However, if one hundred candles are burning and you add one, there may be a just perceptible or just noticeable difference (j. n. d.) in illumination. Suppose, now, that two hundred candles are burning and we add another. No matter how much you are set to perceive a small difference in illumination, you will not perceive the change. It will be below the threshold of discrimination. Likewise, one pound added to two or three pounds (or subtracted from two or three pounds) will lead to a clearly perceptible change in weight. The object will feel heavier or lighter, as the case may be. Add one pound to one hundred, however, and the difference in weight will not be noticed.

In an old psychology text<sup>21</sup> there is a description of an experiment carried out on a frog. The frog sat in water the temperature of which was gradually increased until it reached the boiling point. However, the animal failed to move. It was boiled alive without ever having made an effort to escape. Why? Because the increase in temperature was so gradual (was such a small proportion of the preceding temperature)

that the frog could not at any moment sense an increase in temperature.

These simple illustrations suggest that, whether or not a difference in intensity is discriminated depends upon the ratio of the change in stimulus intensity to the intensity of stimulation existing prior to the change. In other words, whether one discriminates a difference between the intensity of stimulus *a* and stimulus *b* (or a difference in the correlated experiences *a* and *b*) depends upon what proportion the change from *a* to *b* is of *a*. This is known as *Weber's law*, so named because Weber, a German physiologist, whose work was referred to in Chapter 1 (p. 6), first formulated it.\*

In experimental investigations of Weber's law, one stimulus intensity is held constant and referred to as the standard intensity. We then determine what stimulus intensity can be just barely discriminated from the standard intensity. If Weber's law applies, the increase required is a constant fraction of the standard intensity. This fraction is referred to as the *constant* (*C*). When Weber's law applies, the j.n.d. is a function of  $\Delta S/S = C$ , where *S* is the standard stimulus intensity,  $\Delta S$ , the change in *S* required to produce a j.n.d. in intensity, and *C* the constant ratio.

If one candle added to one hundred produced a just noticeable difference in brightness, *S* would be 100;  $\Delta S$ , 1; and *C*, 1/100. Suppose that this ratio applied generally to brightness discrimination; then, how many candles would need to be added to five hundred in order to produce a j.n.d. in brightness? The answer is one to every hundred, or five. The increase (or decrease) must be one hundredth of the

\* This general area of research is known technically as *psychophysics*. It deals with the relations between experienced intensity and physical intensity. The methods used to study these relationships are known as *psychophysical methods*.

preceding intensity, the standard intensity.

The Weber ratio ( $C$ ) varies, depending upon the kind of sensitivity being measured. It is much smaller for visual than for auditory intensity, roughly  $1/100$  as compared with  $1/5$ . It differs, also, with the range of intensities involved, being constant only within an intermediate intensity range.

There are several psychophysical methods, each of which yields a somewhat different ratio.<sup>22</sup> One of these, the method of just noticeable differences, will serve to illustrate how a j.n.d. for visual length of lines could be measured.

We instruct our subject to indicate which is the shorter of two lines. We then pair the standard length (say, 10 inches) with each of several comparison lines, repeating the presentations many times in all possible combinations and with the standard an equal number of times on the right and left. The difference in length between the standard line and the line discriminated from it with an accuracy of 75 per cent is taken to be the threshold (the just noticeable) difference.

A comparison line of 10 inches would, of course, be selected from the standard length (10 inches) with no greater accuracy than 50 per cent, or chance. The standard length, let us say, is differentiated from a line of 10.5 inches with an accuracy of 95 per cent, from a line of 10.4 inches with an accuracy of 87 per cent, from a line of 10.3 inches with an accuracy of 83 per cent, from a line of 10.2 inches with an accuracy of 80 per cent, from a line of 10.1 inches with an accuracy of 75 per cent, and from a line of 10.09 inches with an accuracy of 70 per cent. In this case, unless a finer determination were desired, we would assume that  $10.1 - 10.00$ , or  $.1$ , is the threshold difference. The Weber ratio in this case is  $1/100$ .

The psychophysical methods have been used to develop the decibel scale of loudness, a scale used by physicists and sound engineers as well as psychologists. These methods have also been found useful in many other fields, including those of educational, social, business, and industrial psychology. They are useful whenever we wish to determine how much difference in something must be present before people can notice it. If some practical situation requires that certain differences be perceived, we make sure that the differences are well above the threshold of discrimination.

## PRIMITIVE ORGANIZATION IN PERCEPTION

The term "primitive organization" is a convenient one to represent various aspects of perception which appear to be determined not so much by past experience as by the nature of our sense organs and the structure of our nervous system. There is no doubt that some forms of stimulation arouse similar perceptual experience in all of us. This appears to be independent of previous relevant experience. It would be difficult, and perhaps impossible to prove that such perceptual tendencies are inborn, yet there is every indication that they are. What is especially interesting in this connection is that animals, children, and savages behave as if the stimulating properties of some of these situations were the same for them as for us. This is one reason for supposing that such perceptions are, as it were, imposed upon us by the nature of stimuli and the way in which our sensory and neural structures are organized.

Most of the examples are from vision, but similar principles probably apply, to a less obvious degree, with respect to our other senses. Next to vision, the tactual sense provides our best examples.

Look at these dots:

• •       • •       • •       • •

Even though you may never have seen this particular pattern of dots before, it has a certain degree of organization or meaning for you. You see the dots, not as so many dots, but as four pairs of dots. You probably noticed the grouping before you observed the number of dots. Moreover, the same general configuration (Gestalt) would remain if these were white dots on black; if they were small squares instead of circles; if they were red, or yellow, or blue; and, in fact, in any way they were any visual objects that one might imagine.

The grouping is therefore independent of the particular parts (the dots, etc.) which serve to represent it.

Even outside of vision, the same grouping would remain. Thus, eight taps with a pencil, eight blasts on a trumpet, or almost any eight auditory stimulations imaginable, would produce the same perceptual configuration if presented in pairs with a perceptible time interval between each pair. Likewise, the essential aspect of the configuration would be retained if one were to arrange points of stimulation on

the skin with a large enough distance between each of the paired points (and the pairs of points) to make them discriminable. You would experience four groups of paired points.<sup>23</sup>

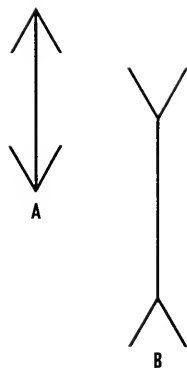
The dot example is but one of many used to illustrate primitive groupings. Illusions exemplify primitive organizations that are somewhat more complicated than the groupings illustrated.

## Illusions

Illusions are "false" perceptions. When we experience an illusion, we experience certain things which fail to correspond with the situation as objectively measured. Illusions should not, however, be confused with hallucinations. The latter (see p. 260) may also be thought of as inaccurate perceptions, or as some prefer to say, dreamlike images which are often mistaken for objectively measurable external phenomena. They differ from illusions in certain important respects. In the first place, although we all experience illusions, few of us ever have hallucinations. While normal people sometimes experience them, hallucinations are usually confined to the mentally ill and those under the influence of drugs. In the second place, illusions always have a clearly apparent external stimulus. Hallucinations sometimes occur when there is no apparent objective stimulus. In the third place, the same situation arouses the same illusion in all subjected to it. That is why we class it with primitive organizations. On the other hand everybody who has an hallucination under particular circumstances has a different hallucination. When one person sees red devils another may see snakes, or dragons, or executions.

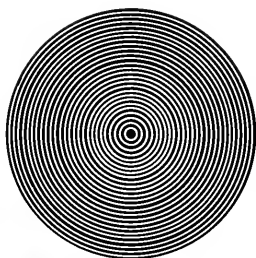
*The Müller-Lyer illusion.* This is illustrated in Figure 14.9. You, in common with all other normal adults, will say that the vertical line in A looks shorter than that in B. Children old enough to indicate the nature of their experience give a comparable report. Some animals react as though they also see what we see. The following experiment with chickens illustrates the procedure and outcome of such an experiment.

Two lines of obviously different length to the experimenter and, as it turned out, of obviously different length to the chickens, were presented in a discrimination apparatus. The shorter line

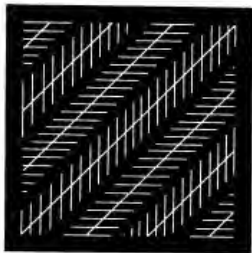


**14.9 The Müller-Lyer Illusion.** Which vertical seems larger from apex to apex, A or B? They are actually the same length.

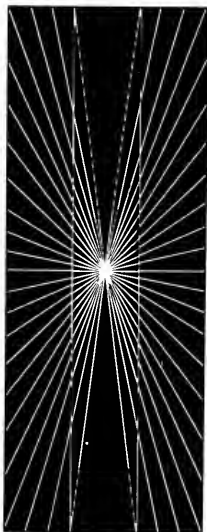
appeared on the right side of the discrimination chamber in some trials, and on the left side in others, the side being alternated in a chance order. The longer line always appeared on the opposite side to the shorter one. The chickens were trained to discriminate between them by approaching the shorter line and avoiding the longer. Whenever they approached the shorter line, they received food. Approaching the longer line brought punishment in the form of an electric shock. After several hundred trials (the number differing from one chicken to another), discrimination reached an accuracy of from 80 to 90 per cent. The difference in length of the lines was then gradually reduced. Moreover, changes in the figures were made so that the chickens would not be disturbed later by introduction of arrows. It is important to note that the changes introduced could by no means be considered training for perception of the illusion, for they introduced no illusory effects. Finally, two lines of equal length, but each bounded by arrows as in the illustration, were introduced. Most animals continued to discriminate (as accurately as they had discriminated the shorter line), the line that to us appears shorter. It was, of course, possible that they were reacting to the overall length of the figure (including ends of arrows) rather than to the horizontal lines as such. That this was not



A



B



C

the case was shown by control experiments. When the overall length of the figures was made the same, by decreasing the length of the line whose arrows flanged outward (the negative figure), there was a marked tendency to choose this, the figure previously avoided. Since the central line of this figure was now actually shorter than that of the other, although the overall length of the figure was the same, it suggests that the chicks had really been responding to the central line all along.<sup>24</sup>

Several other optical illusions are shared by men and birds. The latter make better subjects than other animals because their vision is so good. The Müller-Lyer illusion and a few others that we have not illustrated can also be experienced tactually when made up in the form of rubber stamps and impressed upon the skin. Some optical illusions of greater complexity than those already mentioned are shown in Figure 14.10.


*Illusions of apparent motion.* We all experience the illusion of movement when we witness a moving picture. In the regular commercial motion picture a sequence of events somewhat as follows takes place: a shutter cuts out all projected light, and a new frame with a slightly different picture on it (Figure 14.11) moves into place. The shutter opens and an unmoving picture is projected on the screen. A shutter cuts across this still picture while it remains in position, thus increasing the frequency of flickering interruptions and producing less perceptible flicker. The shutter once again cuts across the field, and a new frame moves up, stops, and is held still. The whole sequence is then repeated for that picture. Thus, there is never any objective movement on the screen itself, which would be seen only as a blur, but rather one sees in a moving picture the most beautiful example possible of synthetic movement.

#### 14.10 Some Other Visual Illusions.

**A,** Move the book with a rinsing motion, as if you were slowly rinsing something in a circular pan. Moving radii will be seen. **B,** The long lines are parallel. **C,** Place a straight edge along the vertical lines to prove that they are actually straight. (A, after S. P. Thompson, 1876; B, Zöllner, 1860; C, Hering, 1861.)

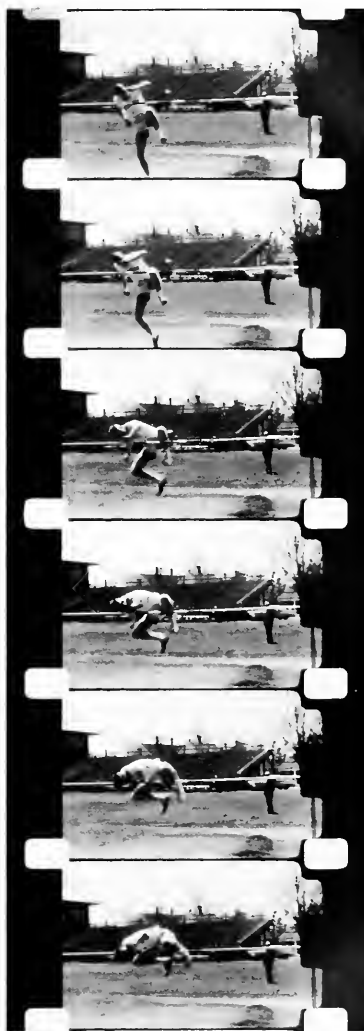


Thus, a succession of still pictures, projected one after the other at a suitable rate, gives us the illusion that movement occurs. This illusion is known as the *phi-phenomenon*. We see it, not only in the movies, but in many electrical advertising signs. The red arrow which appears to move from one position to another does not really move. Two arrows in different positions are flashed on one after the other. Likewise, the greyhound on the bus signs does not really move. We see it running because different positions of the body involved in running are successively lighted at appropriate intervals.

The phi-phenomenon is often studied experimentally by using an apparatus which allows presentation of two or more lights, one after the other.<sup>25</sup> Such an arrangement of lights is . Experimental research has shown that, in order to get the illusion, one must present the lights at an appropriate brightness, size, distance apart, and temporal interval. If the size, brightness, and distance between the lights are held constant, and you view the situation from a fixed distance, the timing factor may be clearly demonstrated. If there is too long an interval between flashes, you see one light go on and then the other. There is no apparent movement. If the interval between flashes is too short, you see two lights flashing at approximately the same time. However, if one flash follows the other at an appropriate interval (the interval depending upon the space between the lights, their size and brightness), you see a light move from one position to the other. That is to say, you see not two lights, but one. It appears to move across the space where no light actually exists.

This illusion is not confined to human adults. Children and animals behave as though influenced by it. The following experiments with cats and guinea pigs are especially interesting.

The animal is clamped into a holder, but with its head free to move. Its eyes face the inside surface of a rotating cylinder covered with alternate vertical black and white stripes. As these stripes move by in a clockwise (or counter-clockwise) direction, the animals exhibit typical right-left head movements (head nystagmus). Thus their eyes follow a stripe momentarily and then return to the original position. Under normal conditions the nystagmic movements are elicited only when stripes are



**14.11** Successive Frames from a Motion Picture. What is projected upon the screen is merely a series of still pictures like these, each slightly different from the preceding one. Observe, for example, the position of the right knee in successive frames. The perceived motion is an illusion.

present and when these are actually moving. Human beings react in a similar manner to such stimulation.<sup>26</sup>

So far we have described the reaction to actual movement of the striped pattern. However, the same reaction occurs when the stripes do not actually move, but are flashed on in rapid succession. This successive presentation of the stripes is produced by use of stroboscopic illumination. The whole inside of the apparatus is dark, except at intervals when the light flashes on. The cylinder moves all the time, but the stripes can stimulate the eye only during a flash determined by the stroboscope. The flashes are synchronized with the moving drum in such a manner that the eye is stimulated only by stationary stripes. Yet the animal acts as though it were being stimulated by moving stripes. These results "seem significant in suggesting that the capacity for apparent movement vision is a fundamental aspect of mammalian vision and is not, as has been implied by some theories, a perceptual capacity based primarily upon some process of learning or acquired perceptual interpretation." The same results are obtained when the cerebral hemispheres are removed. This shows that the phenomenon, at least in guinea pigs and cats, is mediated by mechanisms in the brain stem or retina or both. An explanation in terms of retinal processes has been suggested.<sup>27</sup>

It has been clearly demonstrated that the illusion of apparent motion is not based upon eye movements, for, with two sets of lights like those referred to, but with one set above the other, an observer simultaneously sees one light moving from right to left (above) and one from left to right (below). That is, he perceives movement in two different directions at the same time, something which would be impossible if movement of the eyes from one position to the other were necessary. Nor is the phi-phenomenon due to images. If a light moved across the space between the two positions, we might have after-images of it. Since it does not actually move, there are no after-images representing intermediate stimulation. The phenomenon is apparently dependent upon some rather stereotyped reactions of our visual receptors, or nervous system, or both, to the stimulus relationships involved.

In addition to the groupings and illusions already mentioned, there are several other illustrations of primitive perceptual organiza-

tion. One of these is the phenomenon called *perceptual constancy*.

### Perceptual constancy

The Müller-Lyer illusion and the phi-phenomenon illustrate that what one perceives does not always correspond with what is before him. The so-called "constancy phenomenon" is a further illustration of this fact, although it perhaps has a quite different explanation. It is the tendency to perceive objects as constant, even though they stimulate us in a variety of ways.

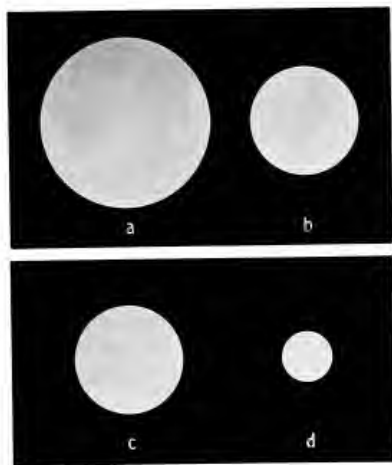
Size constancy is easily demonstrated. Look at some familiar object, say a coin, a pencil, or a book. Hold it close to your eyes. Does the object look smaller as you move it away (thus providing a retinal image of rapidly decreasing size) and larger as you move it closer? The chances are that it does not. It will look smaller only when it is moved much farther away than the length of your arm. Brightness (or lightness) constancy is illustrated by looking at a familiar object and failing to see its brightness change while changes in illumination are introduced. One can illuminate a piece of coal until the amount of light entering the eye is greater than that received from a white shirt, yet the coal will still appear black and the shirt white. Form constancy is exemplified every time we perceive a plate as round when, because of its position with respect to the eye, the image is actually elliptical. Likewise, the square table top is continually seen to be the same square, although, as we look at it from different positions, the image on our retina undergoes a variety of changes. These constancy phenomena are taken into consideration when the artist wishes to create an impression of reality. For example, if he draws a square table top as square from a position in which it is actually impressed upon the retina as a diamond, it looks unnatural to us. He must draw it as a diamond for us to see it as a square.<sup>28</sup>

Relative constancy of perceived objects has obvious utility to the organism. Think of the confusion that would exist if we were to respond to every aspect of our world in terms of its visual image alone. Objects would be seen to shrink or enlarge as the retinal image varied in size, to change their brightness or color as corresponding retinal changes occurred. But, within certain limits, we see things as we

"know" them to be despite what the retinal picture alone would tell us. Everything else we know tells us that they are constant. But, as objects move much farther from us, they *do* seem to shrink in size. This change gives us a clue (p. 416) to their distance. Therefore, there must be some sort of compromise between seeing a thing as constant in size (when near) and as smaller in size when far from us. This is, or course, not an explanation of size constancy. We still need to know whether the tendency to make such a compromise is inborn or acquired, or based upon some interrelation of inherent and learned tendencies. If it is learned, we are certainly not aware of how we see things as constant under certain circumstances and as changing under others.

### Relational discrimination

Discrimination in terms of relationships has been demonstrated in monkeys and other



**14.12** Relational Discrimination. Trained to select **b** rather than **a**, then confronted with the combination **c-d**, the subject usually responds to **d**, the smaller area, rather than to **c**, which has the same area as **b**. Positive response to **a** is described in the text.

animals, as well as children. Situations like those used are represented in Figure 14.12. In a discrimination apparatus, following the discrimination procedure already described, (p. 227), the animal is trained to go to the large circle (*a*) and to avoid the small circle (*b*). After it has learned this lesson well, the subject is confronted with the circle (*c*) and a still smaller circle (*d*). It now goes to (*c*), which is the area that it previously avoided. The animal is not responding to the specific area (*a*), but to the larger of the two areas. Likewise, if we present a larger area than *a* (the area previously selected), the animal now avoids *a* and selects the larger area.

This relational type of response is also found when brightnesses are used, the animal responding to the relation brighter-than or less-bright-than.<sup>29</sup> Animals have been trained to make an absolute response to brightness, but the relational one is obviously more primitive and more easily demonstrated.<sup>30</sup>

In turning, now, to tridimensional vision — the visual perception of depth and distance — we observe further examples of primitive organization. In some instances, however, the influence of past experience is also evident.

### VISUAL DEPTH AND DISTANCE

The apparent size, position, distance, and depth of objects which reflect light onto the retina are judged in terms of a variety of cues, some physiological and some psychological. Sometimes, as illustrated in Figure 14.13, the various bases of judgment combine so as to deceive us. The room seems to be of normal shape, while the man and child are distorted in size. If one of these is of normal size, it seems, the other must be abnormal. The room itself is greatly distorted, as seen in the Appendix. In this section we consider some of the bases of such perceptions.

The retinal image, unless very small, is curved to conform to the curvature of the eyeball. But this curvature is of the same nature as the curvature that we might impose upon a photo by bending it. It involves no real depth.

If there is no depth in the retinal image of objects at different distances from the eye, how do we perceive the third dimension?

It is well to recognize, at the outset, that



**14.13** **How our Eyes Can Deceive Us.** When the man and the boy change places, the man looks very large and the boy looks very small. The room (see one like it in the Appendix, p. 492) is actually very much distorted, yet it seems normal as viewed here. (Photographed by Eric Schaal, *Life*, © Time, Inc.)

there is no inner person which looks at the image on the retina. Nor is the image transmitted, as a picture, to the brain. What happens is that the light pattern on the retina arouses nerve impulses which find their ultimate locus in the visual area of our cerebral cortex. There is reason to believe that the pattern of such impulses is correlated with the retinal pattern in some orderly way, yet without having the characteristics of a picture. It is the reaction of the cerebral cortex to this pattern of stimulation, rather than our reaction to the image on our retina, which gives us our perception of the external world.

Although the retinal image is without depth, there is nevertheless some correlation between certain of its aspects and the "surfaces, slopes and edges of the world" about us. Likewise, although there is no picture transmitted to the cerebral cortex, the cortical pattern is a counterpart of that on the retina.<sup>31</sup>

In Figure 14.14, B, an artist has portrayed the typical visual field of one eye. His picture is flat, yet the spacing of the horizontal lines is so arranged as to give the impression of a floor, or something of the kind, receding into

the distance. The artist has not drawn a picture of anything in particular, yet he has a spacing arrangement which correlates with, or is a counterpart of, an actually receding space. Photographs as well as drawings illustrate similar principles. Thus, in Figure 14.14, A the apparent size of the clods of earth, their detail, and the shadows cast by them are correlates of what was photographed and give us, when we look at the picture, an impression of increasing distance from the bottom up. The picture in Figure 14.14, C is also flat, yet the lines and angles are drawn to represent certain aspects of a real object with depth. In this case, in fact, the lines and angles are drawn so that they may be regarded as correlates of different objects. They are ambiguous, hence we perceive now one object, and now another.

Patterns of nerve impulses doubtless correlate in some way with the retinal image and thus with aspects of the external world. They are not replicas of the things perceived, nor do they picture them, yet they mediate appropriate responses to the tridimensional aspects of space.

Psychologists are particularly interested in the cues which allow us to perceive depth and

distance. The retinal image itself may contain several cues, as we have already suggested. Some of these are as effective when we use one eye as when we use two, hence we say that they are *monocular*. A cue which necessarily involves both eyes is designated *binocular*. Cues depending upon correlates in the visual image are designated *psychological* while those arising from the structure and movements of the eyes are called *physiological*.

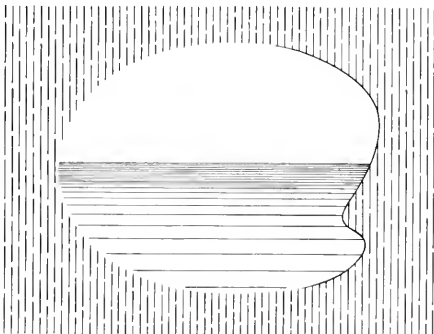
A question which arises in connection with all of these is whether or not we must learn to interpret them. The question is by no means settled. Some psychologists maintain that, at least to a certain extent, our perceptions of

space are *given* to us directly by visual cues, even from the beginning of life.<sup>32</sup> Recent research involving a visual cliff (Figure 14.15) shows that, at least by the time they are able to crawl, infants avoid going over a visual "drop off."

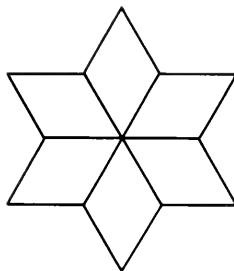
Some maintain that visual cues come to have meaning only as we learn about the world through our other senses. They claim that we learn to interpret these cues through associated tactual and muscular processes. Thus it is claimed that an object comes to look round because it *feels* round; to look nearer than another because the muscular effort in reaching it is less than in reaching the others.<sup>33</sup> This is



A



B



C

**14.14** Some Correlates of the External World Which Give Rise to Perception of the Third Dimension. For interpretation, see text. A, from Gibson, J. J., *The Perception of the Visual World*. Houghton Mifflin, 1950, p. 60; B, *ibid.*, p. 68; C, from Osgood, C. E., *Method and Theory in Experimental Psychology*. Oxford University Press, 1953, p. 255.



**14.15 Infant on a Visual Cliff.** Infants crawled along a heavy sheet of glass toward the mother. Underneath was a textured piece of linoleum. Halfway across, however, the linoleum dropped  $3\frac{1}{2}$  feet below the surface of the glass. In a group of 36 infants  $6\frac{1}{2}$  to 14 months old, only 8 per cent ventured beyond the visual drop-off. The others either crawled in the opposite direction or refused to proceed, even with coaxing from their mother. Similar results have been found in testing white rats on a visual cliff. The study with infants was described by Walk, R. D., and E. J. Gibson in a report to the Eastern Psychological Association (April, 1959) entitled "A Study of Visual Depth Perception in the Human Infant with a Visual Cliff." The study with rats is: Walk, R. D., E. J. Gibson, and T. J. Tighe, "Behavior of Light- and Dark-Reared Rats on a Visual Cliff," *Science*, 1957, 126, 80-81. (Photo by William Vandivert from Gibson, Eleanor J. and Richard Walk, "Visual Cliff," *Scientific American*, April, 1960, p. 65.

not an "either-or" proposition, however, for innate organizations and acquired meaning are perhaps both involved. It has been shown (pp. 410-413) that certain primitive organizations as well as habit factors contribute to our knowledge of the world around us.

#### Psychological cues

Since the psychological cues are just as effective whether we use one or both eyes, they are also examples of *monocular cues*. They comprise the following cues, all represented

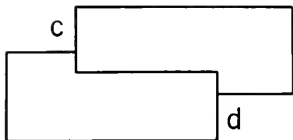
by correlates in the retinal image: size of image, interposition, linear perspective, aerial perspective, shadows, and relative movement.

**Size of image.** The retinal image is larger for nearby than for distant objects. If the distance is sufficiently great, so that size constancy (p. 414) is not involved, we perceive the object as smaller, hence as more distant, when its retinal image is smaller. But we must be acquainted with the actual size of the object. A certain kind of bird is of a fairly constant size, hence when the image is small, we judge the bird to be at a greater distance than when the image is large. In the case of unfamiliar objects, however, the size of the retinal image is of little or no help. Take clouds, for example. These could be of almost any size. What we see might be a large cloud far up or a small cloud near the earth.

**Interposition.** This is a rather obvious distance cue. The object represented in the retinal image as partially obscuring our view of another object is of course judged to be closer. The essential cue is related to the contour lines of the overlapping objects.<sup>34</sup> The object whose contour is continuous at the point of overlapping is seen as closer; the object whose contour is lost at the point of overlapping is seen as more distant. Note in Figure 14.16 that the upper rectangle has continuous contour lines at *c*, hence looks closer. At *d*, however, its contour line is lost while that of the lower rectangle is continuous. Now the lower rectangle seems nearer.

**Linear perspective.** The decrease in the size and separation of objects as they become more distant is often used by artists to represent distance. Lines converging as the horizon is approached give the impression of increasing distance. Trees, telephone poles, and other objects are decreased in size as they recede into the distance. The upper part of the picture always represents the horizon; the lower part the ground, or floor, nearby. The decreasing size of the clouds of earth in Figure 14.14A as they approach the upper region of the picture is also illustrative of linear perspective.

**Aerial perspective.** When we do not know the actual distance of objects, an important cue is provided by the clearness of perceived detail. A mountain, a building, or any other object which stands out from its surroundings, seems closer on a clear day than on a smoky

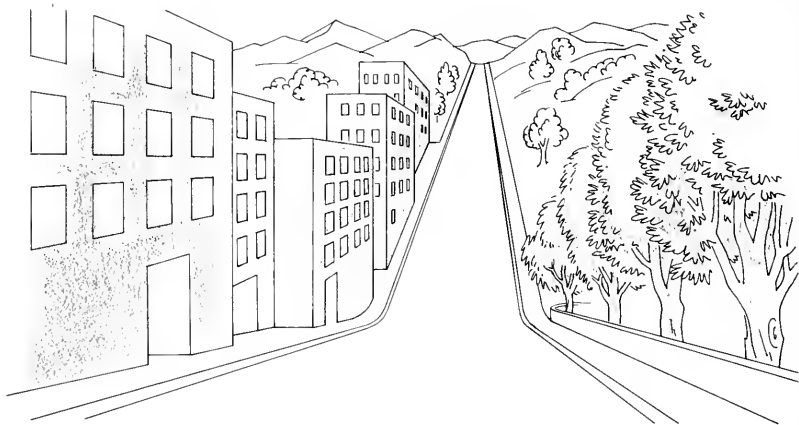


**14.16 The Interpositional Cue.** This figure is ambiguous. At *c* the lower rectangle appears more distant; at *d* the upper rectangle. (From Ratoosh, P., "On Interposition as a Cue for the Perception of Distance." *Proceeding of the National Academy of Science*, Washington, 1949, 35, p. 258.)

or foggy one. In fact any familiar object seems closer when we can make out its details. This is exemplified every time we use binoculars or a telescope, or take photographs with a telescopic lens. It is likewise illustrated by the clouds of earth already referred to. The nearer ones are pictured in greater detail than those more distant.

All psychological factors so far considered are given interrelated representation in Figure 14.17. Observe that the road seems to go down hill, then up. This is because the rate at which the lines are converging in the lower part of the picture changes. The decreased rate of convergence near the end of the fence represents an uphill slope while the *continued convergence* of these lines represents increasing distance. Nearby objects fill more of the picture, as they would the retinal image. Interposition is represented by the fact that some buildings partially obscure others. Aerial perspective is, in a sense, also represented. The nearby trees and buildings, for example, show more detail than those pictured as in the distance. In a fog or haze, less detail would be evident and these objects would be perceived as at a still greater distance.

**Shadows.** Depth cues also come from shadows. Note in Figure 14.18, for example, that the impression of depth may actually be reversed if the picture is turned upside down, thus making the shadows slope in the opposite direction. Note, also, how contours and shadows give depth aspects to the object pictured in Figure 14.19.



**14.17** **How Many Depths or Distance Cues are Represented in This Drawing?** Observe that the road seems to go down hill, then up as it recedes into the distance. At the top it seems to go down again. What other tridimensional cues are evident? (Adapted from Buckley, H. *Perspective*. London, Sir Isaac Pitman and Sons, Ltd., 1947; and by Gibson, J. J., in his *The Perception of the Visual World*. Houghton Mifflin, 1950, p. 139.)

**Movement cues.** The relative movement of objects is sometimes important in judging distance. Other things being equal, the object which seems to move by us rapidly is judged to be closer than that which moves by slowly.

If we ourselves are moving, objects nearby seem to go past in the opposite direction to that in which we are traveling, but distant ob-

jects appear to move with us.

There is evidence that individuals with only one eye depend upon clues derived from head and eye movements as well as movements in the environment. This is especially true for judgment of near distance, as when returning a spoon to a sugar bowl.

Some movie cartoons utilize a combination



**14.18** **The Influence of Shadows on Depth Perception.** This is a volcano crater in Rabaul. Turn it upside down, however, and a mound is seen instead of a crater. *Life* once printed a picture of the moon inverted, in which the craters appeared to be mounds. Photographers often obtain a marked enhancement of depth by an appropriate arrangement of shadow. (Photo from Whites Aviation, Ltd.)





**14.19** **Contours, Shading, and Depth.** Note how differences in shading, with resulting differences in contour make a flat picture have depth. (Courtesy Surface Combustion.)

of psychological cues, including relative movement, to give a very realistic impression that one is viewing a tridimensional picture.

Works of art like that reproduced in Figure 14.20 provide a further illustration of how impressions of depth may be created by use of relative size, interposition, linear perspective and shadows. What one sees is illusory, for

the picture is perfectly flat. Those sitting in the lounge of the ship in which this mural appears in color seem to see a butterfly some inches from the wall, and ladders, ropes, and other objects as real instead of flat representations.

#### Physiological cues

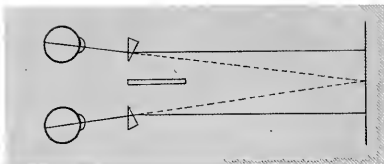
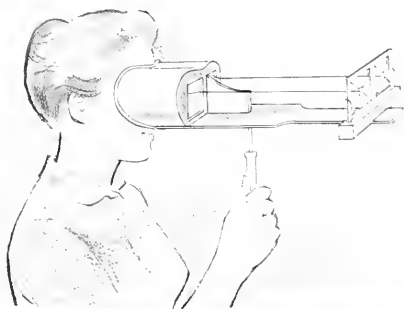
Here we have three generally recognized cues: accommodation, convergence, and retinal disparity. The first is monocular, the second may be monocular or binocular, and the third is binocular.

*Accommodation.* The lens of the eye changes its curvature (accommodates) as we fixate nearby objects. This adjustment is mediated by muscles and ligaments and it is thus possible that resulting nerve impulses provide the brain with cues as to the relative distances of the object fixated.

*Convergence.* The eyes converge (turn inward) more when we fixate nearby objects than when we fixate those at a greater distance. These reactions are controlled by muscles attached to the eyeball, hence nerve impulses generated in the course of this adjustment might serve as distance cues. The same turning movements are made when a person has only one eye. But convergence is of doubtful value as a spatial cue unless the objects fixated are fairly close.<sup>35</sup>

**14.20** **An Example of "Trompe-l'oeil" art.** This painting, from the lounge of the RMS ORSOVA, is reproduced with the kind permission of the artist, Mr. Humphrey Spender and the Orient Steam Navigation Company, Ltd. The picture is discussed in the text.





## 14.21 The Principle of the Stereoscope.

Observe that the prisms of the stereoscope throw the images toward the outer part of the retina, where they would fall if the object were straight ahead. The subject then sees the picture, with depth, at a point between the actual pictures, the point where the dotted lines meet. The small partition prevents the right eye from viewing the picture designed for the left eye, and the left eye from viewing the picture designed for the right eye. Some modern stereoscopic devices for viewing 3-D colored transparencies are described in the text.

*Retinal disparity.* Each eye gets a somewhat different picture of the same object or situation. In looking at an object the right eye sees around the right side a little more than does the left eye. On the other hand, the left eye sees a bit farther around to the left. This difference in the view obtained with each eye is referred to as *retinal disparity*. That it provides important cues concerning depth is well known to anybody who has viewed such pictures through a stereoscope.

The principle of the stereoscope is illustrated in Figure 14.21. Observe that the right eye sees only the picture taken with the camera on the right, and the left eye only that taken

with the camera on the left. The screen prevents either eye from being stimulated in any way by the noncorresponding picture. The function of the prisms is to throw the disparate images on the same regions of the retina which would be stimulated were the original scene viewed by the two eyes under normal circumstances. The tridimensional image, produced by some fusion process in the brain, is projected, as it were, along the dotted lines. These lines are illustrated as extensions of the lines from prisms to retina.

The well-known Viewmaster accomplishes the same result without use of prisms. A stereo camera takes two pictures simultaneously, one from the position of each eye. In looking through the Viewmaster, or a comparable viewer, we place the right-side picture over the right eye and the left-side picture over the left eye, with the result that an extremely realistic depth effect is produced.

You have perhaps observed another application of the retinal disparity principle, for it is sometimes used in store-window advertising and in the moving pictures. The pictures used are printed in two colors, usually red and blue. Instead of being printed as separate pictures, however, they are superimposed. But what would be seen with the right eye is printed in red and what would be seen with the left eye in blue. You now look at the still picture, or movie, through spectacles having a red and a blue filter. The red filter over the left eye prevents you from seeing the red picture (appropriate for the right eye). Likewise, the blue filter over the right eye enables you to see the red picture but not the blue one (appropriate for the left eye). Under these conditions you observe depth, much as in a stereoscope. The result is so realistic in movies of a man pitching a ball toward the camera that most members of the audience "duck, as the ball comes toward them." It appears that the ball leaves the screen and is about to hit one between the eyes. These representations of the retinal disparity principle are known as *anaglyphs*.

A similar principle is involved in the so-called "3-D" movies shown in theatres. In these pictures, however, two separate images are projected upon the screen by a double projector. A polarizing system and polarized filters are used to prevent the right eye from

seeing the left eye's view and the left eye from seeing the right eye's view.\*

Depth perception based upon retinal disparity can be demonstrated in children as young as one year.<sup>36</sup> A doll, for example, is seen between us and the screen. The child with polaroid glasses reaches for the doll where we see it, hence must have "3-D" vision.

Whether 3-D vision is inborn or based upon acquired interpretations is not known. It seems likely, however, that it is another example of "primitive organizations" like the geometrical illusions, illusions of motion, etc., discussed earlier in the chapter.

The principles of stereoscopy have many military uses. Stereoscopic cameras take reconnaissance pictures which make it possible to tell not only that a building stands at a particular spot, but also its height, and many other characteristics. Visual range-finding instruments likewise make much use of retinal disparity and the stereoscopic vision based on it.

## AUDITORY SPACE PERCEPTION

Our ears provide us with certain cues concerning both the *distance* and *direction* of objects, but judgments based upon these cues are in most instances quite crude, especially compared with judgments based on visual cues.

### Distance

If a sound is familiar, we can usually judge its distance in terms of loudness, since we as-

\* The two pictures, one for each eye, are projected upon a special metallic screen. In coming from the projecting lenses, the light from each picture is polarized in a different direction. The light from one picture vibrates in one direction; that from the other, in a different direction. Looking at the screen without special glasses, the viewer sees confused double images. But his polaroid glasses provide filters for the respective eyes which allow only the appropriately directed vibrations to pass through. Thus the right eye sees only what was photographed with the right hand lens of the camera and the left eye only what was photographed with the left-hand lens. The result is a marked impression of tridimensionality. Cinerama produces depth effects in a very different manner from that described. A very wide, curved screen leaves much of the picture in peripheral vision and judgments of depth come from interpretation of what we have referred to as "psychological cues."

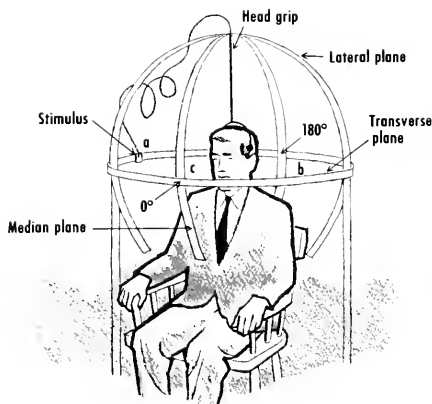
sociate increasing distance with decreasing loudness. Complexity is another possible distance cue. The sound of an airplane motor is far less complex at a distance than when nearby. When it is close, we hear a great variety of sounds. At a distance, however, only the low hum is audible. Likewise, the relatively faint higher overtones of musical instruments become inaudible with distance. Near-by sounds also have greater volume than more distant ones. The boom of a cannon a few yards away seems to fill all space. From a distance of several miles, however, the same boom appears to take up relatively little space. Moreover, it is heard as but one of several sounds. It does not drown out everything else.

### Direction

Our ability to locate sound sources is partially dependent upon previous knowledge. We know, for example, that those traffic sounds are coming from the road over there, that the airplane is overhead, and that the cheering comes from the stadium. Vision also provides us with cues which aid in auditory localization. We hear a woodpecker, for instance. Looking up in the trees and seeing the bird pecking, we locate the source of the sound. It happens, of course, that vision sometimes deceives us. We "hear" sounds issuing from the mouth of the ventriloquist's dummy because we see its mouth moving at the same time as words are spoken. Likewise, we seem to see and hear an actor speak on the screen, even though the loudspeaker may be several feet above, below, or to the right or left of his mouth.

Under such circumstances as the above, only one ear is necessary for localization. All we need do is hear and recognize what we hear. When previous knowledge and vision are eliminated, however, two ears are necessary for localization. This is because we are not able to localize sounds in terms of auditory cues alone unless they stimulate each ear differently.

In a typical experiment on auditory localization the subject sits with closed eyes, his head in the center of what is, in effect, a large sphere. This is illustrated in Figure 14.22. A click may be presented at any position on the surface of the sphere. As soon as he hears the click, the subject must name or point to



**14.22** Schema Illustrating a Situation Involved in Auditory Localization Experiments. The subject may localize by naming the position of the sound or by pointing to it. For further explanation, see the text.

the place from which the click came. His error of localization is measured in degrees. We find that he is able to localize the click fairly well so long as it is at a different distance from each ear. When it appears at *a*, the click is much closer to the right ear than to the left. The subject usually says that it is directly to the right. Suppose that the click is presented at *b* — that is, to the front on the left side. It is closer to the left ear than to the right. Again the subject has good success in localizing the source of the click. Suppose, however, that we present the click directly in front at a position equidistant from the ears — that is, at *c*. Now the subject may say that it is up, back, down, to the front, or in any position in the median plane, which cuts through the head directly between the ears. His accuracy of localization within this plane is no better than could occur by chance. This is because, at every position, the ears are stimulated identically.

What differences in stimulation at the ears are provided by a sound to the right or left of the median plane? There are three important possibilities. These are: (1) a differ-

ence in time of arrival of the sound wave at the ears; (2) a difference in the phase of the cycle activating both ears; and (3) a difference in the intensity of the stimulus at the ears. The sound wave, of course, reaches the nearer ear first; it may be in a different part of its cycle when it strikes the nearer ear than when it strikes the farther ear, and it may have a greater intensity at the nearer than at the farther ear.

Under conditions of everyday life, time, phase, and intensity differences are often simultaneously present, and we may use now one and now another, or all three combined, in localizing unfamiliar and unseen sounds. When the locus is familiar, or the sound source seen, these cues are not necessary, and they are probably not used. When a noise, such as a click, is involved, time is the most important clue as to direction. But when a tonal stimulus is involved, phase also becomes important, especially if the sound wave is of low frequency, hence relatively long. A long wave has a better chance of stimulating the two ears in a different part of its cycle than a short wave. One ear may be stimulated by the crest (condensation), and the other by the trough (rarefaction). In the case of high frequencies, or short waves, on the other hand, one ear may be stimulated by the crest of one wave and the other ear by the crest of the next wave. As far as phase is concerned, this is equivalent to stimulating both ears with the crest of the same wave. Experiments have shown that some individuals localize in terms of phase differences, but others do not.

Intensity is an important cue only at relatively high frequencies, above five thousand cycles per second. This is because intensity is not greatly reduced by small differences in the distance of a sound source from the ears. Significant differences in intensity are associated, rather, with the shadow of the head. A sound wave coming from the right must pass around the head to get to the left ear. Long waves (those of low frequency) bend easily and show little loss of amplitude. On the other hand, short waves (those of high frequency) are so greatly reduced in amplitude that the sound may be thirty db louder at the nearer than at the farther ear. When complex sound waves are involved, this bending around the head not only reduces their loud-

**14.23** **Young's Pseudo-phone.** A tube conveys to the left ear sound waves which would normally stimulate the right ear, and to the right ear those which would normally stimulate the left.



ness, but it also decreases their complexity. Timbre is thus different at the two ears and may provide a localizing cue.

When one wears an apparatus like that shown in Figure 14.23, all the auditory localizing cues are reversed. If the eyes are closed, sounds actually coming from the right are heard coming from the left, and vice versa. If the eyes are open, however, and the sound source is within view, the sounds are properly localized. In other words, visual cues take precedence over auditory ones.<sup>37</sup>

It is only under laboratory conditions that we are able to present one of these localizing cues while holding the others constant, and thus discover the relative importance of each.

#### **Auditory perspective**

In any complex situation, some sounds appear near and some distant; some appear to the right, some to the left, and some straight ahead. Not only this, but certain sounds move in relation to other sounds or appear on a background of constant sounds. Radio engineers have had some success in reproducing such *stereophonic effects* by radio. One method is to place two microphones on a dummy, one microphone in the position of the

right ear and the other in the position of the left ear, maintaining the actual distance which separates the ears. The right-hand microphone is connected to the right earphone of a listener in another room. The left-hand microphone is likewise connected to the left earphone. Now someone walks toward or away from the dummy, around it, and so on, while talking. The listener with earphones has the illusion that someone is walking toward him, around him, and so forth.<sup>38</sup> Similar stereophonic effects are sometimes produced in movie theatres. Several sound tracks may be used, each recorded from a sound source in a different position and each with its loud speaker appropriately located in the theatre.

Musical programs have been broadcast in such a manner as to utilize stereophonic effects and stereophonic records have become commonplace. In each instance, there is a simultaneous pickup from differently placed microphones, and a playback from differently placed loudspeakers. The principles are similar to those of the above-mentioned experiments.

#### **INTERSENSORY CONTRIBUTIONS**

What one perceives of space involves contributions from several senses, separately at

times but often complexly integrated. Visual and auditory information has been stressed. Nonetheless, it has been necessary to recognize (p. 417) that perceiving the depth of seen objects may be dependent upon earlier tactual and kinesthetic experiences. In discussing certain aspects of distance perception (p. 421), it was learned that cues from the muscles which move the eyes and others which change the curvature of the lens may play an important role. We were referring, in this connection, to kinesthetic cues. The interplay of vision and hearing was cited (p. 425) in describing how visual cues may take precedence over the auditory in "auditory localization." Two other senses also provide information which helps us locate sources of stimulation not in contact with the body surface. One of these is olfaction. Although more useful to animals like the dog than to us, it does facilitate the localizing of odorous objects — as when a skunk is in the vicinity or something is burning. Temperature is the other sense which provides spatial information. This is limited to such relatively simple things as locating the direction of a draft, or of warmth.

The tactual and kinesthetic senses, often in combination, tell us about the size and shape of objects that we handle without looking at them. This sort of information has important application in some work situations. Tactual-kinesthetic information is of course crucially significant to the blind.

Our discussion of static sensitivity (pp. 382-383) dealt with mechanisms involved when we discern the direction of bodily movement — up, down, right, left, forward, back, clockwise, or counter clockwise. This is also relevant in the context of space perception because much information that is important for spatial orientation comes from the static sense. Normally, this is combined with other information, especially visual and kinesthetic. It is the combination of these three senses which makes it possible for a cat to land upright when dropped. These senses do not serve us as well, in this sort of situation. Nevertheless, they do facilitate our locomotor activities. When visual cues are absent — as in some diving and flying

operations — one is thrown back almost entirely upon his static sense. This alone can tell him, whether he is upright or upside down. We do not mean to imply, however, that this is an infallible guide. The use of instruments in "flying blind" suggests that it is not too dependable as a means of spatial orientation.

An interesting series of experiments has demonstrated that perception of one's position in space is to a measurable degree dependent upon visual surroundings.<sup>39</sup> Some of these experiments used an apparatus that was illustrated in Chapter 2 (p. 41). With this the body as a whole could be tilted forward or backward or to the right or left. Likewise, the entire visual environment of the subject, who was supported more or less rigidly in the padded chair, could be tilted in the same directions, either with or independently of the body. Individuals differed greatly in their reactions. But most of them had the impression, when the room alone was tilted, that they had themselves changed position. On the other hand, their body could be tilted, in a visually upright environment — the environment also moving so as to correspond — without this movement being perceived.

The apparatus was constructed so that the subject could readjust the visual surroundings and also his own position. Such readjustments were accomplished with variable success, some subjects doing very well and others very poorly.

What is of special interest to us here is this further demonstration of the interplay of different senses in space perception. In a dark room or completely foggy environment — that is, with no visual detail to guide him — one's static sense, combined with tactual and kinesthetic stimulation, might be expected to tell him that he was upright, or tilted. In the latter instance, if he were sitting in a chair, there would be unusual pressure against his side — for example, the right side in a tilt to the right. In a tilted visual environment, however, such cues may be ineffective because the visual ones predominate, a finding reminiscent of the already-mentioned predominance of visual cues in localizing sounds.

## Summary

Attending and perceiving are in some respects indistinguishable, but we have concentrated upon attending conceived of as a preperceptive set — an anticipatory perceptual adjustment.

The act of attending involves receptor adjustments, postural adjustments, muscle tensions associated with the latter, but not always overtly observable, and central neural adjustments, including those of the reticular formation and cerebral cortex. Central neural adjustments are generally considered to be integrally involved in receptor and postural functions, but controversy has centered around the idea that there may at times be a central control independent of, or in addition to, the peripheral adjustments. The possibility of such a central control must be recognized, but research has so far failed to provide conclusive evidence of it.

Three varieties of attending may be distinguished, i.e., involuntary (such as is produced by an unexpected shot), voluntary (as in attending at somebody's request or from a sense of duty), and habitual (exemplified by continuing sets like the mother's readiness to hear her baby's cry).

Determiners of attention may be differentiated into two broad but somewhat related groups — namely, external and internal. To the degree that they contrast with their surroundings or with what is customary, external stimulus patterns gain in attention-getting value. Internal determiners are continuing sets which stem from motives.

From the standpoint of experience, perceiving is synonymous with observing differences, relationships, organizations, and meanings. From the standpoint of behavior, it is synonymous with acting differentially, in terms of relationships, organized properties of the environment, and meaning. Perceiving, considered from either standpoint, involves receptor processes and it may also involve symbolic and affective processes.

Instructional sets facilitate perceiving of items relative to the set. So also do motivational sets which the individual himself brings

to a situation. The research on values and perception of related words has so far had no clear outcome.

Past experience is especially important in determining the meaning of what we perceive. Any familiar object has acquired a variety of meanings because of its association with other objects and events in the past. Thus, perception of an apple is eventually possible in terms of any one of its aspects (such as color, odor, taste), and any one of these is likely to arouse symbolic processes which represent former experiences or activities in which apples have played a part. Growth of meaning is also related to our tendency to interpret the new in terms of the old. Think of the girl who called the caterpillar a "kitty bug" when she saw one for the first time. That the same object may have different meanings for different individuals, even though it stimulates them identically, can be illustrated by use of any object not familiar to all. The influence of set in perceiving is another example of the role of past experience, for the set is itself usually determined by what has happened previously.

If we had to examine every object or situation carefully before perceiving it, we should be greatly handicapped in reacting to our environment. What we do, characteristically, is to react in terms of reduced cues. Some aspect of former experience, or some part of a present familiar object or situation, arouses symbolic processes which, as it were, "fill out" the experience.

In order to perceive stimulations as different, it is necessary that the difference between them be a certain fraction of one, which is referred to as the standard stimulus. This is the essence of Weber's law. If you are to discriminate an increase in brightness, the increase in intensity of light must be about one hundredth of the intensity that you started with. This increase is necessary to bring the difference above the threshold of discrimination, or to produce a just noticeable difference (j.n.d.) in brightness. In hearing, taste, and the other senses, different ratios apply. In every field of reception, they apply only to the middle range of

intensities, they vary somewhat from one individual to another, and they vary under different experimental conditions. Similar ratios apply to certain aspects of the environment other than intensity—for example, length of lines. One of the methods used to obtain Weber ratios is that of just noticeable differences.

Some aspects of perceptual experience and behavior appear to be inborn rather than learned. These have been referred to as primitive organizations. Among the examples presented were primitive groupings, some geometrical illusions, the illusion of apparent motion, perceptual constancy and relational discrimination. In some instances, as in the illusions, we actually perceive as aspects of our environment certain phenomena which have no objective existence. Thus, we may see movement where none occurs, and we may see straight lines as bent, or lines of equal length as differing in length. Since the same illusions are experienced by persons who have never before been presented with such situations, and since animals react as though subject to the same illusory effects, there is good reason for believing that the organizations involved are independent of previous experience.

Illusions, and possibly other forms of primitive organization, are apparently imposed upon us by the organism. The external situation activates certain receptor and neural processes, but what we perceive corresponds with these processes and not with the external situation. Thus, in the phi-phenomenon, we perceive movement because of some process within the eye or nervous system, not because of some external movement. A large amount of research is being focused upon primitive organizations with the aim of finding out what receptor and neural activities are responsible for them.

Although the image on our retina lacks depth, it contains certain cues, correlated with aspects of the external world, which enable us to discern depth and distance. Some of these cues are monocular, requiring only one eye. Among monocular cues are those designated as psychological. They are so named because it appears that we must interpret them. Whether these cues give us any aspects of space perception prior to experience or

whether we must learn to interpret them is an unanswered question. It appears likely that a certain amount of "primitive organization" is supplemented by acquired interpretations.

Important among psychological cues are the following, all of them monocular: retinal size, interposition, linear perspective, aerial perspective or clearness of detail, shadows, and relative movement.

Among the physiological cues of depth are accommodation of the lens (monocular), convergence (monocular and binocular) and retinal disparity (binocular). Accommodation and convergence are of doubtful value except at close distances. Retinal disparity, however, is of obvious importance. It is illustrated experimentally by use of the stereoscope, anaglyphs, and other so-called "3 D" pictures. In each instance, two slightly different pictures, taken with lenses separated by the same distance as the eyes, are fused to produce a tridimensional effect simulating what we see with both eyes.

Depth perception based upon retinal disparity is perhaps another of the "primitive organizations" referred to earlier. It may be clearly demonstrated in children as young as one year.

A sound source equidistant from the ears gives no auditory clue as to its location. When the source is at a distance from one ear different from that from the other, however, the wave (1) reaches the nearer ear first, (2) may lead in phase at the nearer ear, and (3) may be more intense at the nearer ear. These differences enable us to localize the source, but the significance of a particular clue depends on the nature of the sound wave. Time is important for localization of noises, phase for localization of tones, and intensity for localization of high tones.

Space perception, rather than being visual, or auditory, is an intersensory affair. In many instances it is, so to speak, audiovisual. But other senses also provide spatial information: olfaction, the temperature sense, and the static and kinesthetic senses. When visual cues are in conflict with auditory or static cues, the visual may predominate. Examples of this were seen in auditory localization and in perceiving the body position in a tilted visual environment.

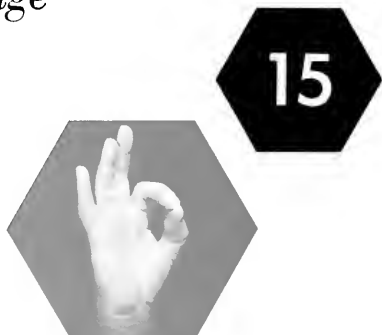
(References and notes for this chapter are on page 566 of the Appendix.)



## Selected Readings

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# Communication and Language



Limitations of animal communication • Linguistic origins • Speech mechanisms  
• Learning to speak • The communication process • The meaning of words •  
Nonverbal communication • Summary

Communication is an integral feature of interaction between organisms. It occurs whenever the behavior of one organism acts as a stimulus for the behavior of another. Sometimes the behavior of one organism is informative. It may indicate that danger approaches, that food is to be found in a particular place, or, at a level of much greater complexity, that a friend is expected to reach New York on Wednesday. In its barest essentials, communication goes something like this: The behavior of one organism acts as a stimulus. The second organism, because of the inborn make-up of its nervous system or because of neural changes that have resulted from learning, responds appropriately to the stimulation provided. At the human level, stimulation may be transmitted through various intermediaries, including telephone wires or cables, not to mention deliverers of the message. Even so, the fact remains that a message is understood only because the stimulation involved arouses appropriate processes in the recipient. In short, there is no transfer of information except in such terms.

Most human interaction involves language, which may be defined in the simplest terms as *communication with gestures or with spoken or written words*. Speech symbols (gestural, spoken or written) are conventionalized, which is to say, bound by rules. They involve stimuli which signify something that is understood, more or less, by both the person who initiates them and the person for whom they are in-

tended. A message "gets across" because the sender encodes his message according to custom and the receiver decodes it in the same terms.

It is well to recollect, in this connection, what has already been said about symbolic processes. Linguistic stimuli are symbols in that they represent something other than themselves. When one wishes to convey a message, in conversation or otherwise, he encodes it, so to speak, in the signals he has learned to make. The recipient decodes the message. He reacts to the symbols in terms of the meanings he has learned to attach to them. This encoding and decoding process is usually quite automatic, unless the code used is a secret one that must be deliberately deciphered.

Speech sounds and gestures, as well as written words, are therefore not *just* sounds, or movements, or scratchings on paper. They are symbols that represent objects or events with which communication is concerned. One who knows the language reacts to them as having conventional meanings. He knows the code, hence he can decode them. The printed symbols, HAT, are generally accepted as meaning a certain kind of headgear. You "get" what is encoded because you know the convention. But take the following symbol: HAŠESAII.<sup>1</sup> What is printed provides visual stimulation. But no message is transmitted, and for the simple reason that you have not learned what this stimulation means. It happens to be Mayan. Thus it arouses no appropriate symbolic counterpart in you, such as a student of this ancient language might have. In short, you cannot decode whatever "message" might be said to be imbedded in the word.

Communication at an elementary level involves no more than the stimulation of one animal by another in such a manner as to produce a similar response in the latter. Thus the chirping of a cricket, or the croaking of a frog, starts up similar activity in others. At a somewhat higher level of complexity, communication may have a signaling function. A response in one animal may signal danger to its less perceptive companions. One antelope, say, reflexly raises its tail and the others, reacting to this reflex as signaling danger, depart hurriedly from the vicinity. At a still higher level, one animal stimulates another to do something positive, like going in search of food or helping it do something. We will see presently that communication at this level is sometimes assumed to involve language. Language in its fully developed form, however, is a purely human accomplishment.

Some will doubtless question the statement that only human organisms communicate linguistically. They will point to the parrot that "talks" or to the dog that learns to "speak" for a cookie. This chapter answers them by calling attention to very real differences between animal and human communications, differences which do not justify application of the term "language" to the former.

Human beings at times communicate as animals do. Communication may involve signals, and even reflex ones, as when somebody screams and people look or rush in that direction. On the other hand, most human communication is mediated by language. Some is merely nonverbal, as when conventionalized gestures rather than words are used. More of it is verbal, involving spoken, written, or printed words. Here we are interested in language from the standpoint of the principles involved in its acquisition and how it functions as a means of communication.

We begin with so-called "animal language." This discussion brings out the basic characteristics of linguistic as compared with other forms of communication. Attention is then focused upon vocal mechanisms and how they produce speech sounds. Acquisition of verbal skills is considered next, although with some recognition of the fact that word meanings are simultaneously acquired. Basic speech functions are described.

Then we examine some informational aspects of language. The processes within the organism that underlie the meanings of words — or which, in a sense, link the name with what it represents — are also considered. Finally, we outline some nonverbal forms of communication in man.

### LIMITATIONS OF ANIMAL COMMUNICATION

All but the simplest animals, through their own behavior, stimulate the behavior of others of their kind. They do this, sometimes by exuding odors, sometimes by emitting sounds, and sometimes by assuming postures. These acts are essentially reflex, as, also, are the responses to them. Certain odors may signal that a female is sexually receptive. Vocalizations may have a similar function. Birds, for example, vocalize to call a mate, challenge an enemy, or proclaim their territorial rights.<sup>2</sup> The howler monkey vanquishes its enemies by literally "howling them down."<sup>3</sup> By assuming a certain posture the baboon warns others from approaching his food or his females. A female chimpanzee, by assuming a mating posture, may divert the otherwise dominant male from a food supply, thus getting more of it for herself.<sup>4</sup> Indeed books have been written about these and other ways in which animals communicate with each other.

#### The "language" of the bees

A highly elaborate form of communication occurs in bees. It is so elaborate as to have been called the "language" of the bees.<sup>5</sup>

Upon returning to its hive from a successful foraging trip, the bee brings with it nectar and pollen. The latter, by itself, may signal the kind of flower visited, possibly through its odor. But more is signaled by a dance which the bee performs. If the food source is nearby, the dance assumes a circular pattern. A more distant source is signaled by a dance which, in its pattern, resembles a figure eight. The bee runs forward, circling now to the right and now to the left. Meanwhile its tail end wags from side to side. The rapidity of circling and tail-wagging signals the distance of the food source. The direction in which the bees must go is indicated by the direction of the run between turns.

How bees decode such information is not

definitely known, although certain details have been discovered. For one thing, other bees imitate the dance of the informant, no doubt instinctively. Then they, too, fly off in the proper direction.

Remarkable as it is, there are marked limitations in this communication between bees. As one commentator says, "You and I can have endless conversation about all sorts of subjects, but bees are able to discuss one thing only — food and where to find it."<sup>6</sup>

#### Communication among chimpanzees

Communication at a much higher level of complexity — at a higher level because it seems to be *intentional*<sup>6</sup> rather than reflex and because it has *symbolic significance* approaching that of human communication — is found in chimpanzees. Take, for example, an experiment on cooperative behavior. Chimpanzees were taught, one at a time, to pull in a box containing food. Then the box was made too heavy for an animal to pull it in unaided. Now there were two ropes (Figure 15.1) and, in order to get the food, cage mates were required to pull at the same time. This was quite a problem. One animal pulled, found that the food box would not budge, then gave up. The other animal pulled, and also failed to obtain the food.

After special training, which called for joint pulling on command, the animals learned to pull at the same time. Finally, without the experimenter's command, the chimpanzees

<sup>6</sup> We qualify this statement by saying "*seems to be intentional*" because there is never any absolute proof of intention. A human being can of course tell us that he intends to do a certain thing (whether or not he actually does it) and he can tell us that he did or did not intend to do something that he has done (like committing a crime) but the limitations of animal communication are such that we can do no more than infer the presence of intentions, hazardous as that may be.

took up the ropes and by watching each other, pulled in unison. Sometimes, however, one animal was more eager than the other. His problem, then, was how to get his partner to cooperate. It is here that gestures approximating language came into play. One animal solicited cooperation by putting its hand on the partner's shoulder and turning it around or by touching it in various ways. When successful, these motions oriented the partner toward the rope. The observer of such behavior cannot escape the impression that the chimpanzee is all but saying "Help me do something."<sup>7</sup>

If the chimpanzee pointed at the rope or handed it to the partner, this could be even more effective, providing, of course, that the partner knew enough to perceive the significance of such acts. Chimpanzees have actually never been known to point, nor to solicit cooperation more directly than by turning another animal in a relevant direction. They come very close to language, yet can do no more than signal, in the most general way, the need for help.

In an experiment on morphine addiction in chimpanzees the addicted animal sometimes took the experimenter's hand and pulled him toward the dispensary. There, at times, it handed him the syringe and bent over for its injection.<sup>8</sup> Here, again, the best the animal could accomplish was to say in effect, "Do something for me."

In short, a chimpanzee's behavior cannot tell another precisely *what to do*. Nor can it in any way *describe* an object or an action.



#### Teaching a chimpanzee to "talk"

An orang-utan<sup>9</sup> and a chimpanzee<sup>10</sup> have been taught to say a few words. However, their accomplishment is far from true speech.

The "talking" chimpanzee, trained by Keith and Cathy Hayes and subject of the latter's book, *The Ape in Our House*, is shown in Figure 15.2. She was treated as a child and called "Viki." At the beginning Viki made no sounds beyond those which chimpanzees normally make when excited. She did not babble. Except when emotionally aroused, she was silent. The initial problem, therefore, was to get her to make nonemotional sounds. This

**15.1 Communication in Chimpanzees.** Top: Bula touches Kambi near the mouth and turns her head toward the grille. Middle: Bula's hand is on top of Kambi's pushing it down toward a rope. Bottom: Bula and Bimba pull together. (From M. P. Crawford, 7, p. 59.)

seemed hopeless. Efforts to induce Viki to "speak" for her milk by making sounds were also, at first, in vain. Accordingly, milk was withheld in the hope that Viki would "say" something. But Mrs. Hayes and Viki looked at each other, or at the milk, and Viki made no sound. When the milk was about to be taken away, Viki let out worried little "oo oo's," typical reflex vocalizations. For making such sounds, emotional though they were, she was given a sip of milk. In the excitement over getting milk, Viki made some reflex barking sounds, and was given more milk. Then, as her appetite wore off, she was silent again. When urged to "speak" she said nothing. The threatened departure of Mrs. Hayes brought more "oo oo's," and more milk was given. And so it went.

Viki was not speaking on command. Noises were, so to speak, "tricked out of her." This continued for five weeks. Then with face contorted, and obviously with great effort, Viki began to make a sound like "ahhh." When she did so, she reached for the milk. Now, at long last, it appeared that she was vocalizing intentionally. Viki then made the "ahhh" sound when she was asked to speak, and also initiated it herself in "asking" for things.

By pressing Viki's lips together as illustrated, and moving them as she said "ahhh," Mrs. Hayes eventually taught her to say something approximating "Mama." Finally she said this without aid, although only on command or under obviously relevant circumstances, as

when it would bring a reward. "Papa" was similarly acquired after Viki had learned to imitate a "Bronx cheer." The word "cup" was a combination of the sounds "k" and "p," one quickly following the other. Viki also learned to click her teeth, signifying that she wanted to go for a ride.\*

Although Viki learned a few words, we are not justified in crediting her with language. When parrots, chimpanzees, or other animals learn to "speak" they do so only under human tuition. Without this tuition, and the patterns set for them by their trainers, like the movements Viki was induced to make by human manipulation of her lips, they never acquire anything resembling speech. To call Viki's few acquired vocalizations "speech" would, in any event, be purely academic. The sounds did not, and probably never would, function like speech. As one writer has pointed out, after reviewing the extensive literature on "animal language," animals do not use their acquired vocal skills to communicate as human beings do. Their vocalizations are stereotyped and closely tied to the situations in which they were conditioned. They are used only in the presence of human beings; not to communicate with another animal. Even more significant is the fact that no animal combines its acquired vocalizations, as words are com-

\* Unfortunately, the experiment was ended with Viki's death from what seemed to be a virus infection.



**15.2 Teaching Viki to Say "Mama."** As described in the text, the lips were first moved while Viki was making an "ahhh" sound. Then, as the lips began to move without aid, touching with a finger was sufficient. (Courtesy The American Philosophical Society.)

bined, to form phrases and sentences. It is also noteworthy that animal vocalizations refer to the present (or possibly the future as in anticipation of milk). They never refer to the past.<sup>11</sup>

When animals learn to respond appropriately to speech, as many do, they are influenced by the pitch, loudness, or pattern of sounds—not by their symbolic content, nor their meaning in a human sense. Perhaps the best example of this was given by Thorndike, who trained cats to run to a box when he said, "I must feed those cats." After this conditioning had been accomplished, he said, "My name is Thorndike." The cats ran to the box as before. They did this, also, when he said, "Today is Tuesday." In fact, any vocalization that he used had an equivalent effect.<sup>12</sup>

### The role of insight

Even when animals learn to vocalize with apparent intent, as Viki did, they still lack insight into the significance of the sounds they are making. This difference between animals and human beings is interestingly exemplified by the blind and deaf Helen Keller. One morning during her seventh year, Helen patted Miss Sullivan's hand and pointed to running water, signifying in this way that she wanted its name. The word w-a-t-e-r was spelled out on her hand in the manual alphabet. Later, while filling a cup at the pump, Helen had the word w-a-t-e-r spelled out again. This time the cold water was overflowing on her hand, and the spelling of the word at the same time had a remarkable effect. This is described by her teacher, Miss Sullivan:

The word, coming so close upon the sensation of cold water rushing over her hand seemed to startle her. She dropped the mug and stood as one transfixed. A new light came into her face. She spelled "water" several times. Then she dropped to the ground and asked for its name and pointed to the pump and trellis, and suddenly turning round she asked for my name. I spelled "teacher." Just then the nurse brought Helen's little sister into the pump-house and Helen spelled "baby" and pointed to the nurse. All the way back to the house she was highly excited, and learned

the name of every object she touched, so that in a few hours she had added 30 new words to her vocabulary.<sup>13</sup>

Helen had discovered that *everything has a name*. After this, she began "to see the world in a new light." She had "learned the use of words, not merely as mechanical signs and signals, but as an entirely new instrument of thought."<sup>14</sup>

### Where are animals lacking?

It is somewhat of a mystery why animals fail to develop languages in the human sense and why under human tuition, an animal as intelligent as a chimpanzee fails to achieve insight into the significance of words. The difficulty does not appear to lie in the vocal mechanisms. Parrots and chimpanzees, for example, have a wide vocal range and even do a fairly good job of imitating human vocalizations.

Some writers feel that a necessary prelude to development of speech is the vocal play, or babbling, in which human infants engage. They feel that, since animals do not vocalize spontaneously, but only in a reflex manner when emotionally aroused, an important stepping stone to language is missing.<sup>15</sup>

The absence of vocal play could itself be due to the failure of animals to develop anything corresponding to a motor speech area, a region of the left motor cortex which, in man, controls speech movements.<sup>16</sup>

A deficiency that is every bit as important as absence of babbling or the lack of a motor speech center is the low level of symbolic functioning in animals. Symbolic processes were discussed earlier (pp. 312-314) in relation to the delayed reaction test. There we observed that, whereas some animals recall absent stimuli after a delay, human beings do much better on such tests—recalling after a longer delay and under conditions of greater complexity. Such recall is possible because persisting neurological changes, referred to earlier (p. 310) as engrams, can be reactivated when a proper new stimulus situation arises. As we said in earlier discussions, the reactivation of such "neural traces" is basic to all symbolic processes that an individual acquires.

The prelinguistic symbolic processes of ani-

mals and children seem to possess "all the functions of language except the social characteristic of interstimulation and response." True language, it may be maintained, "grows out of the symbolic processes used by some animals in the solution of the types of problems represented in the delayed-reaction experiment."<sup>17</sup> What this means is that the symbolic processes of animals are insufficiently evolved to make the transition from nonlinguistic to linguistic symbols. The reason perhaps lies in their brain structure, especially the small proportion of the brain that is given over to functions of association, as compared with sensorimotor duties. The frontal lobes, which are so prominent in man and possibly of particular significance for symbolic functions, are also much less pronounced in animals. This is true even at the chimpanzee level.

Such deficiencies as we have mentioned are doubtless interrelated. That is to say, the absence of vocal play and a low level of symbolic functioning are tied in with such features of the animal brain as its smallness; its associative insufficiency, particularly in the frontal regions; and its lack of specialized motor structures corresponding to the motor speech area in man.

In stressing symbolic processes at the level of recall (as in the delayed reaction experiment) we must not overlook one other extremely important fact: the appearance of language requires much more than ability to recall. It requires insight and reasoning as well. It calls for the sort of understanding that came to Helen Keller when, in a flash, she discovered that things may be represented by names and followed up this insight by seeking the name of everything around her.

Nor must we overlook the fact that our remote forbears didn't merely discover language. They *invented* it. In fact they invented many languages, in different parts of the world, and apparently in complete independence of each other.

Each individual who is born today has a relatively easy task, compared with that of his remote human ancestors. Instead of starting from scratch as the earliest human beings must have done, he is handed a language which is, so to speak, ready made for him. All that he has to do is learn it, difficult as this may be for some.

## LINGUISTIC ORIGINS

How man made the transition from non-linguistic to linguistic communication is unknown. This "whole day of creation" or "whole chapter in evolution," as one philosopher has called it, is perhaps forever beyond our comprehension.<sup>18</sup> The reason is that primitive men, although they left relics of their tools and other implements, and paintings on the walls of caves, could not, until writing itself was invented, leave any information about their speech. However, absence of information on the earliest forms of verbal behavior and how they were invented has not prevented scholars from theorizing. There are, in fact, many theories about the origin of speech, but this is not the proper place to consider them in detail. It will be sufficient for our purposes to sketch two interrelated theories which psychologists have put forth, not with the implication that these are correct, but only to indicate a line of reasoning that receives some support from what is known about human learning today.

It may be said at the outset that the only essential condition for the development of a new language is isolation of a group of individuals with no ready-made means of communication. One way or another, they will soon acquire means of communicating with each other.<sup>19</sup> One speech theory comes from Judd, who calls attention to the fact that children sometimes chance upon (or invent) expressions and then use them to represent objects. For example, one child was heard calling pebbles *pocos*, a term which did not come from its environment, hence must have been made by chance (or invented) and then adopted to represent pebbles. Judd says:

When the world was young, the opportunity for inventing new words must have been unlimited. Even in that far-away age, however, the inventor's task was less than half accomplished when he emitted the new sound. Before he could regard his task as complete, he must induce his neighbors to use the sound as he had used it.<sup>20</sup>

The other theory, proposed by Thorndike, stresses chance associations between babbling sounds (say *ug*) and objects perceived at the same time. Thorndike says:



Consider a child of early man playing with a large shell. . . . Let us take the state of affairs least favorable to connecting the sound *ug* with that shell. . . . Let his prattling possibilities consist of a thousand syllables all equally likely to occur in any one situation or in any other. Then the chance that he will utter *ug* as he puts a pebble in the shell is 1 in 1000 if he prattles at all.<sup>21</sup>

Should the child, out of all these possibilities, happen to make the *ug* sound, more will be needed to establish this as representative of the shell (or pebble, or act of dropping the latter). The *ug*-shell association will need considerable strengthening, otherwise some new sound, or none at all, will next time accompany dropping of the pebble into the shell. In this connection, Thorndike says that

there are forces which tend to cause progress away from purely miscellaneous vocal play. First of all the child who puts one pebble in the shell is likely to put another in then and there. His enjoyment of the act makes him repeat it, that is, strengthens its connection with the mental set in which he did it first. Now that mental set happened at that time to evoke also the vocal play of saying *ug*, and the confirming reaction which the enjoyment of the manual play set in action tends to spread or scatter so as to strengthen also the connection of the situation with the utterance. . . . In the second place, saying *ug* to the shell and pebble may be itself enjoyable and the connection may thereby be strengthened. Consequently, the probability that the child will drop a second pebble is substantial and the probability that he will utter *ug* therewith if he utters anything is far above 1 to 1000.<sup>22</sup>

Note that both of these theorists refer to *children* vocalizing. This is perhaps because children, more than adults, engage in random vocalizations. Here, as earlier (p. 435), we observe an emphasis upon babbling as a significant stepping stone to speech. It is interesting to note, moreover, that Frederick the Great is reported to have begun an experiment (thought to be of possible Biblical import) in which children were reared in isolation with a view to seeing whether they would naturally speak Hebrew. The experiment

ended, so it is said, with the death of the children.<sup>23</sup>

Whether the first words were chanced upon, or invented, and by children or adults, there was still the problem posited by Judd: namely, that of having the sounds adopted by others as symbols for the objects (or events) which they represented for the discoverer. It is unlikely, unless they had unusual insight, that adults would have taken over the sounds from children. It is possible that preverbal adults themselves engaged in spontaneous vocalizations — that they prattled to themselves and that associations like those suggested by Thorndike took place at the adult level. But how did such sounds receive acceptance from the group, so as to become conventional symbols for the things represented? No doubt prestige was an important factor. It is not uncommon today for people to adopt some saying or gesture because the person who initiates it has prestige.

Once man attained the idea of using sounds to represent objects or events, there must have been a marked acceleration of verbal behavior. A human child today, after it begins to talk, soon adds new words at a rapid rate. Helen Keller, when verbal insight came to her, began a greatly accelerated linguistic development. In the case of primitive man, the initial idea, however it occurred, was probably followed by the *invention* or *search* for new vocalizations to represent the various facets of his world.

Gestures probably have an origin corresponding, in many respects, to the beginnings of speech. Whether conventionalized gestures preceded or followed speech, or whether they developed concurrently, is a controversial point — and again one that is apparently beyond solution.

It is rather generally agreed that writing followed the development of speech. Its special virtue is that "it makes possible the transmission of cultural acquisitions in a manner much more extensive and permanent than that rendered possible by either gestures or vocalizations, which depend, of course, upon personal contacts."<sup>24</sup>

The first written language that we know anything about used pictures to represent objects or events. In time the representations became increasingly sketchy, as in Figure

15.3. Quite often, only a fragment of the original picture was retained to represent the object. Then, even this departed more and more from the original. A word (or letter) now bore little or no resemblance to the picture from which it originated. The representations had indeed become symbolic. This process was notably important in that it fostered the association of sounds with written symbols. Except in a few instances, as when the sound *buzz* might be used to represent what makes it, sounds bear no resemblance to the things represented.<sup>o</sup> Pictures do bear a resemblance. But with neither the written nor the spoken sign resembling what was symbolized, it was a relatively short step to the use of written symbols as representing sounds, or vice versa. Thus the written symbol for *eye* also represented the sound *i*. Take, as a further example, the letter *M*, already illustrated. This originated in the Egyptian picture of an owl. The spoken word for owl began with the sound "M." Finally the *M*, now not looking at all like an owl, came to represent the sound "M."

The final stage in evolution of writing came when the separate "M's," "i's," etc., were combined in the same order as the sounds of oral speech to form written words.

This very short sketch of the antecedents of man's verbal behavior prepares us to examine his speech mechanisms and to describe how speech sounds are produced.

#### SPEECH MECHANISMS

Looked at from one standpoint, speech involves many motor skills. It requires that the diaphragm, the lungs, and the muscles of the chest as well as the vocal cords, mouth, tongue, and lips (Figure 15.4) be manipulated in ways which are very complex. The motor skill aspect would be even more apparent if we had to activate these structures with our hands, as a violinist, say, manipulates the strings and bow of his instrument. Beyond motor skill there are such factors as the sort of information which the vocalizations

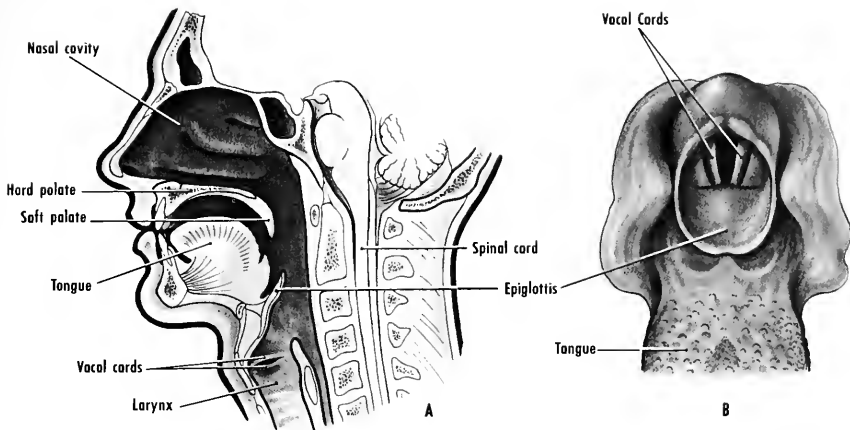
<sup>o</sup> This is known as *onomatopoeia*, and it is involved in a theory of speech origins which supposes that the first words were sounds like those made by the objects represented.



**15.3 From Picture to Letter.** The Egyptian hieroglyphic for owl looked very much like this bird. It was, in fact, a stylized picture. Successively, in the Egyptian, Phoenician, and Greek it approximated our letter *M* below. The significance of this transition is discussed in the text.

transmit and, related to this, their meaning for the person who produces them and the one who listens. These aspects are considered later.

Let us look at the vocal cords, two membranes stretched across the interior of the box-like larynx at the level of the Adam's apple.



**15.4 Speech Mechanisms.** Note the position of the larynx and vocal cords. Drawing B gives a view of the area in blue from above.

Without these it is still possible to speak, but only in a whisper. The vocal cords add “voice” to what is said.

We normally cause our vocal cords to vibrate by forcing air up the windpipe, using the lungs as a bellows. When the opening between the vocal cords (the glottis) is only a small slit, which means that the membranes comprising the vocal cords are tightly drawn, there is rapid vibration, resulting in tones of high pitch. A larger opening, with the membranes under less tension, produces lower tones. With a wide open glottis there is no more than whispering. This is true, also, when disease necessitates removal of the larynx.

To produce high tones one also raises the larynx itself, while to produce lower tones he lowers it. This fluctuation of pitch with the position of the larynx can be observed while feeling one’s own Adam’s apple. Tonal quality is modified by resonance cavities within the chest, head, and nose—as when we say that someone speaks with a “nasal twang.”

Vowel sounds are produced by the vocal

cords with relatively little obstruction or modification by the other speech mechanisms. Consonants, on the other hand, are produced by various changes imposed upon the expelled air. There are fricative consonants, like *th*, *sh*, and *z*, which are so named because friction resulting from lip, tongue, teeth, and palate is required to produce them. In making these sounds we can note how it is done. There are also explosive consonants, like *p*, *t*, and *ch*. In giving attention to one’s own production of these it will become evident why they are called explosive. Consonants like *m* and *n* involve resonating cavities of the nose, hence are said to be nasal.

The mechanisms so briefly described are of course under nervous control. Messages are, as it were, “encoded” by the brain and sent, via the motor speech area, the brain stem, and peripheral nerves to the vocal musculature. Association areas in the brain are of major importance for speech, for it is in these areas that engrams are laid down and interconnected to produce the so-called “association

of ideas." Feedback from the auditory receptors, as when we hear ourselves speak, is also of the utmost importance for speech. Experiments in which the auditory feedback is delayed produce stammering, stuttering, and, as mentioned earlier (p. 185) a great deal of frustration. We will see presently that auditory feedback is a necessary condition in the development of babbling, an early step in learning to speak. Kinesthetic feedback is likewise important, but perhaps to a lesser degree than the auditory.

An infant's initial vocalizations are reflex reactions, but emitted rather than under the control of external stimuli. Such reflex sounds are, so to speak, the basic ingredients of human speech. It is out of these, as well as others that make their appearance as the infant matures, that the words of the language are built. The child's motor task is to combine such sounds in ways which make them have representative significance for himself and those who listen to him. That is, he must learn to encode a message—and also to decode similar messages initiated by others.

Although speech is learned there is always the limiting factor of maturation. The increasing production of new sounds as the infant gets older is probably due to maturation of vocal mechanisms. Babbling may be delayed until the third month or later because the motor cortex is not sufficiently developed. Even after words are spoken, we observe limitations usually attributed to immaturity of the vocal mechanisms—for example, the inability of an infant to say "light" instead of "yite." No doubt maturation and learning play an interdependent role in speech development; so interdependent, in fact, that it is often impossible to disentangle their respective influences.

#### LEARNING TO SPEAK

One may look upon the infant's initial vocalizations (or phonemes) as operants which, if and when they are reinforced, "gradually assume forms which produce appropriate consequences in a given verbal community." These "unpatterned vocalizations," these "raw responses from which verbal behavior is constructed" are not produced by

any known stimuli. In terms of our earlier discussion of operants (p. 276), they are "emitted."<sup>25</sup>

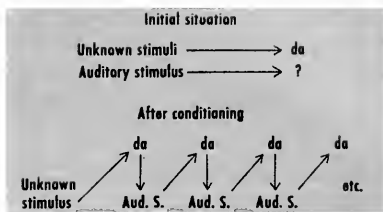
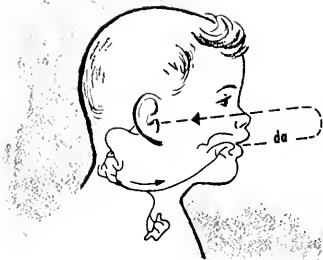
Since we cannot control the stimuli which underlie these early vocalizations, we must, if we are going to reinforce them, wait until they occur. It has been suggested, however, that such vocalizations become, in time, self-reinforcing.

The infant of course hears the sounds that he makes and, through kinesthetic feedback, perhaps also senses the motor aspects. He thus engages in a form of self-stimulation that may, in and of itself, be rewarding. Secondary reinforcement may also supplement whatever reinforcement is inherent in the vocalizations *per se*. This might come initially from the mother's voice. In caring for the infant's needs she usually speaks to it. Through this association with feeding, changing diapers, and so forth, her voice perhaps becomes a secondary reinforcer. Then, through the process of stimulus generalization (p. 275), the infant's own voice may acquire the properties of a secondary reinforcer. After this, the sounds that he makes, as well as those of the mother, may have rewarding values. They perhaps "sound good" to the baby.<sup>26</sup>

#### Babbling

An important stage in learning to speak is marked by the transition from indiscriminate vocalizing to babbling, where a particular vocalization is repeated, as in *da-da-da . . .* and *lal-lal-lal . . .* Babbling becomes prevalent around the fifth month. Deaf babies, although they make noises, do not babble.<sup>27</sup> This is probably because they do not obtain the auditory feedback and reinforcement which infants with normal hearing enjoy.

On the surface, babbling is a form of self-imitation. But how is it established? According to one widely accepted theory, it is a conditioned sequence, with the sounds made by the infant himself serving as conditioned stimuli for their repetition.<sup>28</sup> The theory supposes that some sort of stimulation, presumably internal, leads to emission of the initial response, such as *da*. Then, once the *da* response is made, it becomes an external stimulus, the sound "da." Since the response and



**15.5 The Reflex Circle Concept of Babbling.** The child, in making the sound "da," stimulates himself in two ways. He hears himself say "da" and at the same time kinesthetic impulses from the vocal musculature feed into his nervous system. Finally a reflex circle (left) is established, with the sound "da" serving as a stimulus for its re-arousal. The diagram at the right amplifies this process and is elucidated in the text. (After F. H. Allport.)

the associated sound occur close together in time, this contiguity may be all that is needed to make the sound a conditioned stimulus for the response, thus producing the sequence *da-da-da*. . . . This possibility is presented in the diagrams of Figure 15.5.

Our diagrams take no cognizance of reinforcement, although there is the additional possibility that each sound emitted by the baby reinforces the response which produced it. That is to say, circular connections like those described "may be strengthened by the rewarding value of the child hearing himself produce a sound similar to that produced by his mother."<sup>29</sup>

When the baby starts a chain of vocalizations like *da-da-da* . . . this runs its course until fatigue sets in, or until some other stimulus gets the right of way.

#### Acquiring words

The next important step in learning to speak is copying (or attempting to copy) the verbalizations of others. Having learned to imitate himself, the child now attempts to copy others. If someone says "da," for example, the child who has learned to imitate his own "da" may copy this response. If the word happens to be "door," or "doll," the child, if he attempts to copy it at all, will do the best he can, which may well be "da." A closer approximation comes in time. The trial-and-error proc-

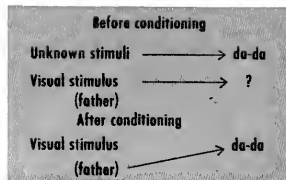
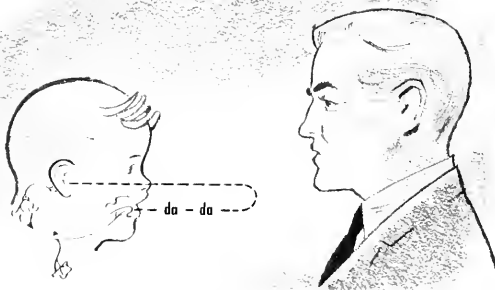
ess involved in learning to say words as others say them was described earlier (p. 287). This requires considerable motor skill, involving the vocal cords, tongue, and other speech mechanisms.

Acquiring the motor skills of speech is one thing; learning the meaning of what is said is another. This is true even though skill and the appreciation of meanings may, to a certain extent, develop concurrently.

At an elementary level, the acquisition of word meanings may be accounted for on a conditioning basis. The child says "da-da," let us say, and the father appears. This happens a few times, perhaps with unusual attention (picking the child up, fondling it, etc.), and shortly the father, or anyone resembling him, is represented by the vocalization "da-da." The situation may be diagrammed as in Figure 15.6. At this stage of development, anything presented repeatedly while the infant is emitting a particular vocalization may come to be represented by the latter. The psychologist, John B. Watson, arranged for a milk bottle to be brought whenever his child said "da-da." Subsequently the milk bottle became "da-da" and "da-da" apparently *meant* the milk bottle.<sup>30</sup>

#### Analysis of verbal behavior

The first words acquired are usually nouns. This is to be expected in view of the fact



## 15.6 Learning a Word. By association with the sound emitted by an infant, an object may come to be represented by that sound. (After F. H. Allport.)

that the most obvious aspects of an infant's environment are objects. At 18 months, when the vocabulary averages 145 words, about 80 per cent of them are nouns. Nouns continue to predominate. Next to nouns, the most prevalent words are verbs. Adjectives come next. By the third year, as the child is beginning to pick up the rules of syntax, the parts of speech come to have a frequency more in line with their relative prevalence in his culture.<sup>31</sup> We will have more to say about this when statistical aspects of language structure are considered.

Skinner's analysis distinguishes between verbal habits in terms of their functions rather than their grammatical classification.<sup>32</sup> He differentiates, for example, between what he calls *mands* and *tacts*, and he sees a somewhat different origin for each.

The term *mand* has been adopted by Skinner to designate words, phrases, or sentences which have an element of demand or request — like "Up," (meaning "Lift me up,") "Give me," or "Go!" It is noteworthy that mands are emitted, presumably under the influence of some internal motivating condition. They are reinforced by the favorable response of the person addressed. Although mands are regarded as operants (as emitted rather than externally elicited responses) external stimuli may come to provoke them, as in the case of a child who, seeing candy in a window, asks for some.

*Tact* is a term invented to represent verbalizations which name, symbolize, or represent aspects of the environment. The term suggests the idea of "making contact with" the things or events represented. To quote Skinner: "In very general terms we may say that behavior in the form of the tact works for the benefit of the listener by extending his contact with the environment, and such behavior is set up in the verbal community for this reason."<sup>33</sup> The origin of a tact may be envisaged somewhat as follows: A doll, let us say, is presented. The child at first has no name for it. He hears the word "doll" or is perhaps urged to say it himself. He may, as in our earlier illustration (p. 441), say "da," the best he can do. But this response is reinforced by what follows — excitement, praise, fondling, and so on. Gradually, through what appears to be a trial-and-error process (p. 287), the child develops enough skill to say the word in a manner completely acceptable to those around him. The names that we have for aspects of our world and the phrases and sentences that we use to convey information about them conform with Skinner's concept of the verbal tact.

Although words are learned in ways already described, many are acquired in other ways. People point at things while naming them. They hand the child various objects and name them while doing so. The child asks for the names of things, as Helen Keller did in the

incident cited earlier. Names are picked up from overhearing conversations, from being read to, and from formal education in the classroom. The meaning of many words that are new to the child is learned through their verbal context.<sup>34</sup>

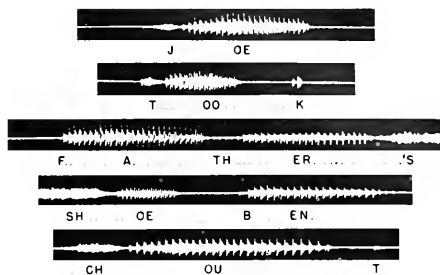
In this process, there is what was previously referred to (p. 292) as "learning to learn." The child is soon "using language in order to learn language." Indeed language becomes so much a part of the individual and everything he does that its general utility is taken for granted. As one noted psychologist has put it, "teaching of the ability to use language correctly and with grace is probably as general a 'training of the mind' as it is possible to carry out," and "in a most important sense, the development of language in an individual is the growth of the human mind in that person."<sup>35</sup>

Nothing has been said about the meaning of words beyond the fact that the object named may be considered the "meaning" of the word used to represent it. But there is of course much more to meaning than this. Many words are conceptual in nature. They represent not particular things, but categories — like animals, people, trees, and houses. These words and meanings are acquired ready-made in some instances and in others through a reasoning process in which abstracting and generalizing (p. 351) play an important role. Quite obviously, many conceptual words (like *life*) are used, even by adults, with only a limited understanding of what they mean.

The problem of word meanings receives further attention as we discuss the communication processes. Later we will have something to say about the origins of meaning and how it is represented within the organism.

## THE COMMUNICATION PROCESS

Communication involves a chain with at least three major links—a sender, a communication channel, and a receiver. The sender encodes a message. That is to say, he puts what he wants to communicate into the appropriate signals. These may be puffs of smoke, drum beats, dots and dashes, or some other conventional representations of letters, words,



**15.7 Representation of the Auditory Stimulus.** The words encoded here are "Joe took father's shoe bench out." (From Licklider, J. R. C., D. Bindra, and I. Pallack, "The Intelligibility of Rectangular Speech Waves," *American Journal of Psychology*, 1948, 61, 2.)

or numbers. Thus encoded, the signals are transmitted via a communication channel — for instance, air, wires, or printed pages. When a person receives such signals he decodes (transforms) them so as to get the message. Thus the person who witnesses a deaf-and-dumb sign message translates the gestures into words, the reader of a Braille message transforms into words what he feels with his finger tips. The reader of this page, although he may not realize that he is doing so, actually translates the printed signs into words. If the signals are carried by conventionalized sound-wave patterns, like those in Figure 15.7, the receiver likewise decodes them to get a verbal message.

Telephone engineers are naturally interested in the encoding, transmission, and decoding of messages, and especially the most efficient ways of transmitting information. It should not be surprising, therefore, to learn that investigators at the Bell Telephone Laboratories and other research centers have introduced a type of study, known as *information theory*, which involves the detailed analysis, often mathematical, of all aspects of the transmission process. What may be surprising, however, is that information theory has extended its influence far beyond the practical issues

of transmitting information over cables or telephone wires.\*

It should perhaps be made clear at the outset that this type of study uses the term *information* in a highly restricted sense. The term has reference only to the encoding, transmission, and decoding of signals in a message. There is, for example, no attempt to deal with what a message means to the recipient. The word *democracy*, let us say, could be encoded, transmitted, and decoded perfectly, but still mean different things to different people, depending upon their particular background. Information theorists are concerned with meaning indirectly, however. Suppose that a message becomes distorted during transmission — humming in telephone wires, static on radio, poor picture or sound transmission on television, or even typographical

\* Information theory has had broad ramifications in various fields of science. In neurology it has influenced concepts of how receptors encode information, how the neurons transmit this to the brain, and how the brain decodes it. In the general area of automation it is influencing the design of the so-called "electronic brains." A chess-playing machine has been invented and some success has been achieved in designing machines to translate languages. In the general field of linguistics (the scientific study of languages) this approach has focused attention upon certain statistical (or probabilistic) characteristics of language structure, such as the greater probability that one letter will be followed by a certain specified letter than by others. Examples of this occur later in the text. In psychology, the information approach has influenced research on learning and the thought processes as well as the area under discussion here, where linguistics and psychology overlap. The present discussion attempts no more than to sketch this approach to communication in its broadest outlines. The details are formulated in mathematical terms which we shall not attempt to present, but which the interested reader may find in such references as the following: Shannon, C. E., and W. Weaver, *The Mathematical Theory of Communication*. University of Illinois Press, 1949; Quastler, H., (Ed.), *Information Theory in Psychology*. Free Press, 1955; Cherry, C., *On Human Communication*. Wiley, 1957; and Attneave, F., *Applications of Information Theory in Psychology*. Holt-Dryden, 1959. Also see Locke, W. N., and Booth, A. D., *Machine Translation of Languages*. Wiley, 1955, and "Brain Translates Russian," *Science News Letter*, June 27, 1959, p. 406. This cites the need for participation of editors after the machine has finished.

errors or smudging on a printed page. In this event, the receiver might lose the meaning intended because he failed to get the signals clearly. Distortions of any sort which are irrelevant to, or interfere with transmission of messages are referred to by information theorists as *noise*.

The information approach has another peculiarity beyond its failure to consider meaning, and this is basic to the entire undertaking. It is the idea that information reduces uncertainty in the mind of the receiver. Let us suppose that you pronounce a letter of the alphabet and I hear you, but not well enough to make it out. In this event, I can do no better than guess that it was any one of the 26 letters. The only thing I know definitely is that you spoke. It is clear that my uncertainty here is a function of the number of possibilities. If you had merely tossed a penny, my uncertainty as to whether you would say "heads" is much less than in the above example, namely a function of two rather than of twenty-six possibilities. Thus "the word information relates not so much to what you *do* say, as to what you *could* say. That is, information is a measure of your freedom of choice when you select a message."<sup>36</sup>

### The bit

When there are only two possible messages — like "heads" or "tails," "yes" or "no," "true" or "false," or "good" or "bad" — it is said that the selection of one of these transmits a unitary amount of information, or one *bit*.<sup>\*</sup> This does not have the usual meaning of "bit," such as "a small piece." It has meaning here only in terms of how much one's uncertainty is reduced by selection of the alternative. One bit is thus any amount of information which reduces uncertainty by one half. Saying "yes" when one could have said either "yes" or "no" reduces uncertainty by one half, or provides one *bit* of information. In fact the number of bits in a communication is assumed to be the logarithm to the base 2 of the number of possibilities from which the choice might be made. With four possibilities, the transmittal of one provides two bits of information,

\* An abbreviation of binary digit, the 1 or 0 so widely used to encode information in computers.



A	1	1	1	
B	1	1	0	
C	1	0	1	
D	1	0	0	
E	1	1	1	
F	1	1	0	
G	1	0	1	
H	1	0	0	
Sign	1st	2nd	3rd	Solution

## 15.8 Some Features of Information Theory.

In the text we have said that information reduces uncertainty. This fact, together with an understanding of the bit as a unit of information, is illustrated here. Note that there are eight consecutive letters A–H. As the experimenter, I have in mind, let us say, the letter C. The subject is asked to discover the letter I have selected, and with the fewest possible guesses. If he adopts the most efficient strategy, he will begin by asking something like this: “Is it among the upper four?” The answer I give is, of course, “Yes.” He has, in this move, reduced his uncertainty by one half. He has one bit of information. Now, if he is wise, he will ask something comparable with: “Is it one of the upper two?” The answer being “No,” he has reduced the preceding uncertainty (upper or lower pair) by half. Another bit has been gained. Only one more bit is necessary to solve the problem. He gets this by asking, for example: “Is it the third?” The answer is “Yes” and his information is complete. By asking questions at random, the individual might get the answer quickly or he might not. The chances are that a random guess would yield less than one bit, as defined in information theory. The bit, as we said in the text, is a contraction of binary digit. Such digits, as illustrated here, are often used to code information. Yes could be encoded by 1, No by 0; True by 1, False by 0; On by 1, Off by 0; and so on. Morse code (dot-dash) and punched card systems of storing information also use binary encoding. (From material in Cherry, C., 6, 170–171.)

with eight possibilities, three bits, and so on. By looking up 26 in a log<sub>2</sub> table we find that the hearing of one letter of the alphabet, as

in our earlier example, would provide 4.7 bits — providing that the speaker is as likely to use one letter as any other. The concept of information as reduction of uncertainty and use of the bit as an index of this is amplified in Figure 15.8 and the accompanying legend.

### Statistical characteristics of language

We have said that the above considerations apply if all possible signals have an equal probability of occurrence. It is an interesting fact, however, that linguistic sequences have contingent probabilities. Putting it otherwise, the appearance of one letter depends to a certain extent upon the letter that preceded it. Thus there is a greater probability that *u* will follow *q* than that *l*, or *p*, or *x* will follow it. By the same token, if *q* is in an English message, *u* will almost certainly follow. In this event, the appearance of the *u* adds little or no information beyond that given by *q*. The same considerations apply to words. Some are used much more frequently than others. In fact the appearance of any word in a message is highly predictable from a knowledge of those which preceded it. It is unlikely that the word *dear* will be followed by *water*, *snake*, or *sky* but very likely that it will be followed by words such as *Sir*, *Madam*, *friend*, *sweetheart*, *lover*, or a person's name.

Information theorists and other students of linguistic behavior are therefore very much interested in the statistical characteristics of language. For one thing, if the probability of occurrence of certain sequences were known, this could also enter the mathematical formulae which represent the informational aspects of communication. The search for knowledge concerning these aspects of our language has revealed some interesting facts.

If all twenty-six letters of the alphabet were put in a hat and drawn blindly, one at a time, with what had been drawn replaced, we would get some such sequence as the following: rxkhrjffbzl. This is zero approximation to the contingent probabilities of English sequences and it doesn't look at all like English. But suppose we draw one letter and have an individual use it in a word, then select the following letter in this word, again

having another person use it in a word, and so on. By this procedure we obtain a first-order approximation to the sequential characteristics of English.\* To make this point clearer, let us suppose that the letter *p* was drawn. The person to whom we gave it wrote the word *pin*. We have *p* and *i*. The letter *i* is given to another person who, let us say, writes the word *life*. This gives us *p*, *i*, and *f*. The person given *f* perhaps writes *fall*, which adds *a* to our sequence. This procedure gives us some such series as *pifaota . . .*, which is obviously more like English than our first example. For a second-order approximation, we take two letters at a time. Suppose that the letters selected first are *g* and *l*. Our first subject, instructed to use these in a word, writes *gland*. The next subject is given the letters *a n* and asked to use this combination in a word. Suppose he says *ancil*. The next subject is given *v i* and perhaps writes *vipers*. The next subject gets *p e* and may write *peach*. And so on, with

the next subject being given *a c*. This will give us a sequence like *glanviac . . .* Following this general procedure, but taking three letters at a time, then four letters, one comes to the point finally, when he has something much more recognizable as English, even though it is scrambled. The following passage, with a space introduced between each approximation to a word, represents a third-order letter approximation: *in no ist lat whey cratict froure birs grocid pondenome of demonstratures*.<sup>37</sup>

The same general procedure may be followed with words instead of letters. One word is selected. A subject makes a sentence involving this word. The next word in his sentence is given to another subject, and so on. In higher approximations, word pairs, triads, and so on, may be given for the start of a new sentence. One such investigation yielded many sequences from which we have chosen the examples in Figure 15.9. From the top down, they represent zero to fifth-order approximations of English word sequences. The last line is from actual text.

\* There are as yet no probability tables for letter or word sequences, hence the present method. There are, however, other ways of getting the same kind of data. These are discussed in the previously mentioned books on information theory.

#### Redundancy

Another interesting feature of linguistic communication, and related to what we have just

**15.9 The Statistical Structure of English.** The upper example, obtained as described in the text, shows zero approximation to statistical properties of word sequences in English. Approximation to English is successively closer in lower lines until, in the bottom one, we have an example from actual English text. (From Miller, G. A., and J. A. Selfridge, "Verbal Context and the Recall of Meaningful Material," *American Journal of Psychology*, 1950, 63, 184-185.)

byway consequence handsomely financier bent flux cavalry  
abilities with that beside I for waltz you the sewing  
was he went to the newspaper is in deep and  
tall and thin boy is a biped is the best  
saw the football game will end at midnight on January  
they saw the play Saturday and sat down beside him  
the history of California is largely that of a railroad

been discussing, is known as *redundancy*. In everyday language, this refers to the tendency to indulge in verbiage—to use more words than are necessary to convey our message. In the preceding sentence, for example, the words following *verbiage* are redundant. Then, why write them? The justification in this instance is that for some readers, they make the point of the first part of the sentence clearer than it would otherwise be. Generally speaking, however, redundancy is frowned upon. It is believed that one should get his point across in as few words as possible.

In information theory, on the other hand, the term *redundancy*, like *information* itself, is used with a special meaning, a meaning within the context of the idea that information reduces uncertainty. This special use of the term is not unlike its general use except that it places redundancy in a somewhat more favorable light.

Linguistic sequences, as we have just observed, contain certain letters (like *u*) which almost inevitably follow other letters (like *q*). Thus, with *q* in the message, *u* is excess baggage. Redundancy is almost 100 per cent. Nevertheless, if *q* should be garbled in transmission (due to noise), the presence of the *u*, as well as the general context of the message, might enable one to fill in the missing letter. Many letters are, of course, less redundant than *u* in the example cited. The letter *h* follows *t* with a high frequency, but *a*, *i*, *o*, and other letters may follow it, although probably not *k* or *x*. The same principle applies to words and phrases. Their sequential probabilities introduce redundancy, but this reduces uncertainty in cases where noise interferes with transmission. *Dear*, before *Sir* is redundancy of this kind, as is *Sincerely* after *Yours*.

It has been claimed that redundancy in English is about 50 per cent—that “about half of the letters or words we choose in writing or speaking are under our free choice, and about half are really controlled by the statistical structure of the language, although we are not ordinarily aware of it.”<sup>38</sup> One of course learns this structure as he acquires the letters and words and phrases of the language, quite often as rules of good usage.

Even apart from the redundancy in linguistic sequences, that introduced on a purely individual basis has certain merits. One may

use more words than are essential to get a message across, but at the same time this increases the probability that it will actually make the intended impression. Thus, “a magnetic storm can garble the telegram ‘I love you’ into ‘I hate you’ but the message could be sent as ‘I love you, darling.’”<sup>39</sup> In this event the word “darling,” although redundant, guards against such a marked error in transmission as to change the overall meaning of the message.

Without involving ourselves in the mathematical details of information theory we have outlined its major concepts and shown something of what it reveals about linguistic communication and the structure of our language. An important topic with which information theory does not deal will now receive attention. This, as we said earlier, is the problem of meaning.

## THE MEANING OF WORDS

One of the greatest impediments to effective communication is the fact that many of the words used are insufficiently conventionalized in meaning. Words which merely denote, or “point to,” an object do not give us too much trouble. Take the word *pencil*. It means much the same thing to all of us and has little meaning beyond “an elongated object containing lead and used in writing.” Connotative words, on the other hand, are often troublesome semantically. This is because, in addition to signifying particular objects or events, they can have additional implications. As an example of this the word *pig* will serve. It represents what we might otherwise call a *hog*, but it has also come to signify unclean, greedy and obese. What is worse, it is sometimes applied to human beings!

Certain other connotative words are much more troublesome than those which designate an object. These include words like *equality*, *freedom*, and *democracy*. The meanings of words in this category are especially difficult to pin down. Moreover, they are often used with connotations which their origin does not justify. Our difficulties with them are highlighted in international communication. Sometimes the intended meanings cannot be translated readily into another language. Even when words are translated the inter-

pretation placed upon them may be different from our own. For example, an English-speaking member of the United Nations "says 'I assume'; the French interpreter renders it 'I deduce'; the Russian interpreter 'I consider'. — By that time the assumption idea has gone with the wind!"<sup>40</sup> Problems of this nature fall within the general area of *semantics*, "the systematic study of meaning."

Lewis Carroll, in *Through the Looking Glass*, tells how Alice ran into a semantic problem:

"... There's glory for you!"

"I don't know what you mean by 'glory,'" Alice said.

Humpty Dumpty smiled contemptuously. "Of course you don't — till I tell you. I meant 'there's a nice knock-down argument for you!'"

"But 'glory' doesn't mean 'a nice knock-down argument,'" Alice objected.

"When I use a word," Humpty Dumpty said in a rather scornful tone, "it means just what I choose it to mean — neither more nor less."

"The question is," said Alice, "whether you *can* make words mean so many different things."

"The question is," said Humpty Dumpty, "which is to be master — that's all."

The semantic problem also receives attention in George Orwell's *Animal Farm*, where the commandment "All animals are equal" is finally changed to read, "All animals are equal but some animals are more equal than others."

It is easy to give examples of semantic difficulties but quite another to arrive at a solution. In general, there are three facets to linguistic meanings: (1) a word's meaning as derived from its history, (2) its meaning to the individual in terms of his own experience, and (3) the bodily process which represents the relation between words and the things (or events) that they symbolize. Let us consider each of these in turn.

#### Cultural and personal origins

It is always interesting to learn where a word came from and how its meaning grew (or changed) with the passage of time. When he learns this word, however, the individual usually knows nothing of its history. Much of its potential meaning is therefore

lost upon him. One writer puts it this way:

Every word is a heritage from the past, and has derived its meaning from application to a countless number of particulars differing among themselves either much or little. When now I utter such a word, I throw at the listener's head the entire residue of its previous applications. . . . In uttering a word, the speaker necessarily offers to the listener the whole range of its meaning.<sup>41</sup>

This does not imply, of course, that the speaker himself necessarily knows the full range of a word's meaning.

Despite the broad historical meaning that a term may have, both the speaker and the listener are limited in their understanding of it by their individual pasts. To the child who was given a milk bottle every time he said "da-da" (p. 441) this expression came to mean something quite different from what it means to a child whose conditioning has associated "da-da" with a certain man. We have cited a very simple case. Moreover, the first child will later learn the "proper" meaning of *da-da*. But many denotive meanings are acquired on this level. The actual meaning acquired depends, as in this example, upon the patterns set by the child's elders. These, although in a limited sense, are carriers of the historical meanings of words. Moreover, there is much more to it than this, as we indicated earlier in discussing how a child acquires words and how, in time, he uses particular words to categorize aspects of his world, like *dog*, *life*, and so forth. Also, as a person grows older, he learns the meanings of words from their context, and also from dictionaries, which define them in terms of other words.\*

\* Many scientific words are coined as knowledge develops — words such as *radium*, *x-ray*, *neuron*, *synapse*, *penicillin*, and *cybernetics*. Then, too, the scientist sometimes redefines terms so as to give them more limited meanings in scientific discourse than in everyday life. Examples are words like *energy*, *information*, and *intelligence*. There is also a disposition in scientific circles to "pin down" the meaning of a word so that it denotes no more than the operation required to reveal the phenomenon in question. A purely operational meaning of intelligence therefore is merely "what one measures with an intelligence test." Also see, in this connection, the discussion on pp. 79 and 82.

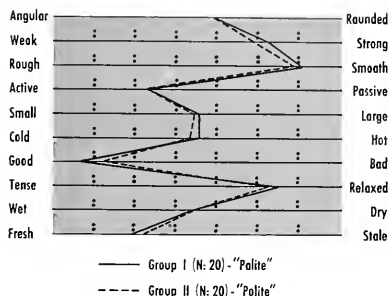
In acquiring words which categorize aspects of our world—and particularly words like *capitalist*, *unionist*, *Republican*, *Democrat*, and *oriental*—we often acquire a semantically erroneous tendency. This is the tendency to assume, for example, that orientals are a class and that any oriental is like every other oriental, any capitalist like every other capitalist, and so on. Korzybski was particularly concerned with such problems in what he called “general semantics.”<sup>42</sup> The sort of difficulty involved is well illustrated by the following quotation from S. I. Hayakawa, also a leader in general semantics.

In spite of the fact that my entire education has been in Canada and the United States and I am unable to read and write Japanese, I am sometimes credited, or accused, of having an “Oriental mind.” Now, since Buddha, Confucius, General Tojo, Mao Tse-tung, Syngman Rhee, Pandit Nehru and the proprietor of the Golden Pheasant Chop Suey House all have “Oriental minds,” it is hard to imagine what is meant. The “Oriental mind,” . . . is purely and simply a fiction. Nevertheless, I used to note with alarm that newspaper columnists got paid for articles that purported to account for Stalin’s behavior by pointing out that since he came from Georgia, which is next to Turkey and Azerbaijan and therefore “more a part of Asia than of Europe,” he too had an “Oriental mind.”<sup>43</sup>

The solution, of course, is to be much more discriminating in our use of conceptual terms than we normally are. One important aim of general semanticists is to make people more cautious in their use of words.

### The meaning of meaning

What is the meaning of “meaning?” Put otherwise, what is the nature of the engram which links a symbol and the object symbolized? We know that word meanings are learned. It is generally agreed, also, that meaning must be somehow represented in the nervous system. Beyond this, however, there is nothing but theory.<sup>44</sup> Some theories stress subjective processes. For example, an image represents the object named. Others look for behavioral forms of representation.



**15.10 The Meaning of “Polite.”** Observe how closely two separate groups of college students agree in the meaning that they attach to the word “polite.” This illustrates one use of the semantic differential, described in the text. (After Osgood, C. E., 46.)

Osgood<sup>45</sup> stresses the idea that meaning is mediated by “some fractional part of the total behavior elicited by the significate.” In other words, the meaning of *dog* for me is represented by abbreviated forms of such reactions to dogs as stroking them, pushing them away from me, jumping back from them, and being afraid of them. Thinking of certain actions and objects, as well as words, is associated with action currents in the muscles involved (p. 349). What the above quotation implies is that such highly abbreviated reactions, if aroused in the past by an object (or event) may come to represent it within the organism. Our discussion of the completely paralyzed man (p. 350) may have some relevance here. According to the present theory, words and events could have no meaning to him during his paralysis, unless, possibly, they were emotional meanings mediated by his autonomic nervous system. Unfortunately, the data do not offer evidence on this point.

Before theories of meaning can be evaluated one must have some way to measure a word’s meaning and represent it in quantitative terms. Osgood and his collaborators have made a move in this direction. It involves a technique called the “semantic differential.”

### The semantic differential

We are already familiar with something very much like the semantic differential. The procedure is similar, in some respects, to that used to discover the feelings associated with a particular emotion, such as fear. One may recall, from the discussion on page 179, that fear was designated unpleasant, tense, and so on. This was the meaning of fear to the individual who offered the report. Likewise, facial expressions of emotion (p. 180) were rated on a scale with pleasant at one extreme and unpleasant at the other.

In using the semantic differential to represent word meanings, one asks the subject to rate a word within various dimensions, like *weak-strong*, *angular-rounded*, *rough-smooth*, and so on. Each dimension covers a seven-step scale, as indicated in Figure 15.10. Here we see what the adjective *polite* means in terms of such semantic analysis. Note how it is rated with respect to each dimension. Also observe that two groups of college students gave the word a very similar semantic profile. For all of them it meant rounded, strong, smooth, active, and so on, and to approximately the same degree in each dimension. One is not to conclude, however, that polite means no more than these things, even to the subjects of this experiment. Osgood himself says that this procedure pins down only part of a word's meaning. In Figure 15.11 it may be observed that the adjectives *eager* and *burning* have certain meanings in common (strong, active) and others in which they differ (bad-good, dry-wet.)<sup>46</sup>

Analysis of data obtained with the semantic differential shows that three major factors are involved. These have been designated *activity*, *potency*, and *evaluation*. The activity factor includes such meanings as fast-slow, active-passive, and excitable-calm. Within the potency factor are included such meanings as hard-soft, masculine-feminine, and strong-weak. Evaluation involves meanings like good-bad, kind-cruel, and beautiful-ugly.<sup>47</sup>

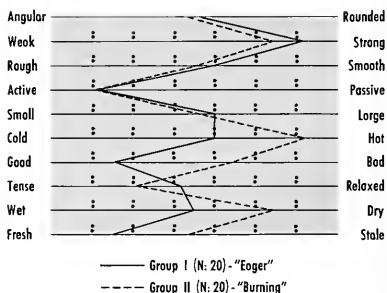
The semantic differential represents the first systematic effort to quantify word meanings. One of its weaknesses has already been mentioned — it does not embrace every aspect of meaning. A related weakness is that it places

more emphasis upon the emotive or feeling aspects of meaning than upon the referent of a word. Thus the word *dog* refers to an animal with certain categorized features, and it means this to any two persons with the same cultural background. Nevertheless, one may rate it on the semantic differential as active, the other as passive; one as good, the other as bad; one as weak, the other as strong, and so on, these meanings in each case depending upon personal experiences with respect to dogs.

Despite its limitations, the semantic differential has been useful in many areas of research, including aesthetics, attitude measurement, and mass communications. According to Osgood and his collaborators, "there is nothing surprising about this. Meaning is one of the most significant pivotal variables in human behavior, and even a crude and very provisional measure of it, such as the semantic differential now is, readily finds uses."<sup>48</sup>

### NONVERBAL COMMUNICATION

Any stimulus can be said to communicate something to the person who responds to it. However, the term *nonverbal communication* refers to transmission of culturally significant information, and without using words.



**15.11 Semantic Differentiation of Two Adjectives.** One can see that to the 20 students here represented, "eager" and "burning" are alike in some dimensions of meaning but different in others. (After Osgood, C. E., *ibid.*)

Nonverbal communication seems of small importance, compared with verbal communication, until we look into it closely. Then we discover that it is extremely prevalent, subtle, and informationally efficient. In many instances, as the authors of a recent book on this subject have shown, a nonverbal act may convey meanings that words are not adequate to convey and, where words may be adequate, if we use enough of them, the nonverbal act conveys the same information much more quickly.<sup>49</sup> All that we attempt in the following discussion is to suggest the extent to which nonverbal communication exists and to give a few examples.

Gestures provide a good starting point. But we must exclude gestures which have the same significance as words — like the gesticulations of a person “speaking” the deaf-and-dumb language and the stock exchange clerk signaling an order (Figure 15.12). These motions are *verbal* — hand talk. They are ways of expressing words which would otherwise be encoded vocally, or in writing. And they are conventionalized to the same extent that vocal and written expressions are.

Nonverbal gestures, while they do not represent words, must also be conventionalized. If they were not, they would lack communicative significance. Any well-acted pantomime conveys meaning because it uses gestures, in their appropriate setting, with which we are all familiar. In every society there are many conventional gestures. Some of these are stylized in the dance, as in Bali, Japan (Kabuki), and in Hawaii (hand motions). Isolated examples are gestures like head-nodding, head-shaking, nose-thumbing, thumb-jerking on the highway, traffic signals with the hand, and others of the kind illustrated in Figure 15.13. Most people in a given culture know when such gestures are appro-



## 15.12 Gestures Which Encode Verbal Information.

In many situations where oral signals may not be heard, a conventional hand talk has been adopted. These pictures show some of the signals used at the American Stock Exchange. Top: signal means that 500 shares are wanted at best offer. Middle: A clerk signals an order to buy 700 shares. The same finger combination given with a downward sweep, would be an order to sell 700. Bottom: A specialist flashes a  $\frac{3}{8}$  bid (bent fingers) and  $\frac{1}{2}$  offered (upright finger). Signals range the alphabet and give fractions down to  $\frac{1}{16}$ . (Courtesy Peter White and the New York Times Magazine.)



## 15.13

**Nonverbal Communication.** Do you “get the message” encoded in these gestures? If not, see the explanation in the appendix.

priate, how to make them, and what they signify when seen. And we should not, in this connection, overlook such vocal yet nonverbal signs as “wolf whistles” and “Bronx cheers.”

In addition to the gestures which have conventionalized significance only within a particular culture, there are others of almost universal significance. Some emotional expressions, but not all of them (p. 176), are of such a nature. This is quite evident when one looks at the photographs in Edward Steichen's *The Family of Man*.<sup>50</sup> There we see that certain situations in the life of all men arouse similar expressions — smiling in happiness, embracing in love, weeping at loss of loved ones, and dancing in exuberance. In their respective settings, these expressions are nonverbal avenues of communication.

Another feature of gestures is worth our attention and that is their use as an adjunct to verbal communication, not only in public speaking and acting but also in ordinary conversation. Here they may be used to punctuate what is said, or to give added emphasis. Some national groups notably use their hands as well as their mouths while communicating.<sup>51</sup> Most of us do this to a certain extent, but not always in a conventionalized manner. The conventionalized use of such adjuncts to speech is seen in pointing, slapping the forehead with the palm of the hand, snapping the fingers, and pounding the table with the fist to emphasize a statement.

How one walks may also have communicative significance. A person may walk “as though he is master of all he surveys” or he may walk in a manner which indicates utter despair. He may have an effeminate gait, although what this signifies is not always certain. Sailors and farmers often have their gait as an unintentional “trade mark.” The sounds made by an individual in walking may also serve as signs of his imminent appearance.

More removed from gestures we have such nonverbal signs as “the old school tie,” the Phi Beta Kappa pin, the sort of clothes a person wears, the kind of car he drives, whether he eats lunch at a restaurant or carries a tin lunch box. What is often signified by such signs is social status. Status of a sort is also signified by wearing beards in a predominantly beardless society, or a certain kind of jacket and long sideburns.

A recent book calls attention to additional aspects of what its author calls the “silent language.” He particularly notes the utilization of time in nonverbal communication — as when, in our own culture, being late for an appointment is taken as a sign of disrespect and keeping a person waiting in your outer office for an hour may signify his unimportance, if it is not an intentional insult.<sup>52</sup>

Some nonverbal communication originates without the direct involvement of other people. A barrier across the road indicates that we have gone as far as we can go and a car with its front end bashed against a broken



telegraph pole tells us that there has been an accident.

The reader need only look around him to

discover many other instances of nonverbal communication and to appreciate their importance in human interaction.

## Summary

Animals have neither gestures nor sounds which are sufficiently conventionalized and flexible to warrant the claim that there are animal languages. Even the chimpanzee, almost human as it is, has no language. Some chimpanzees come close to language in their efforts to get others to help them. But the best they can do is no more specific than a gesture implying, "help me do something." The chimpanzee taught a few words learned these only after intensive training. When animals learn words, these have very limited significance, they are not combined as words normally are, and there is no effort to use them in communicating with other animals.

Language involves conventional signals. Conventionality is crucial, for both the initiator and the recipient of a message must understand the rules that apply, otherwise nothing is communicated. Words, as well as gestures used for linguistic communication, are symbols. Encoding, decoding, and appreciation of their meaning require the use of symbolic processes.

Why man alone developed language has been the basis of much speculation. The following are probably of great importance in this connection: the size of his brain, the preponderance of associative tissue, and the presence of a speech area. Related to such features of the brain are man's high level of insight and his tendency to engage in spontaneous vocalizing. We pointed out, in the latter connection, that animals do not vocalize except when emotionally aroused.

Although human beings invented language, how they did so is unknown to us. Theories mentioned in this chapter stressed the idea that chance vocalizing in the presence of an object may have led to adoption of the same sound to represent the object. After someone had achieved the insight that objects could be represented by sounds, the development

of language must have undergone marked acceleration. Attention has been called to the evolution of writing, which began with pictures and ended with symbols which represented the sounds of speech.

The vocal cords add voice to what would otherwise be whispers. Verbal habits are complex motor skills which involve, in addition to the vocal cords, the diaphragm, the tongue, the lips, and other structures of the mouth and throat. The nervous system is of basic importance in this connection, for messages are encoded in the brain and then transmitted to the vocal musculature via the motor speech area, the brainstem, and peripheral nerves. Feedback is also important. This comes from hearing oneself speak and from kinesthetic impulses originating in the peripheral motor mechanisms.

The initial vocalizations are operants. They are reinforced by the reactions of others to them and also, possibly, by the resemblance of the auditory feedback to sounds made by the mother. Babbling, generally regarded as an important stage in the development of speech, is apparently a conditioned response, with the self-initiated sounds becoming stimuli for their repetition.

Objects presented while an infant is vocalizing may be represented later by particular vocalizations, as in the case of *da-da* and the milk bottle. After having learned to imitate his own sounds, as in babbling, the child attempts to copy sounds made by others. With increasing maturation and practice, these sounds come to approximate those of adults.

Verbal behavior may be analyzed from the standpoint of grammar (parts of speech and syntax) and from the standpoint of how it functions in communication. With regard to its functions, Skinner has invented the terms *mand* and *tact*. Mands are such functions as demanding or requesting. Tacts name

objects or events and impart information. Although early mands and tacts are conditioned reactions, later acquisition of such functions is based, among other things, upon the fact that language is used to learn more language.

Information theory is concerned with the communication process, but it uses the term *information* in a highly restricted sense; viz., as reduction of uncertainty. An amount of information which reduces uncertainty by half is called one *bit*. A message may be inadequately transmitted, even garbled, by extraneous factors referred to, in general, as *noise*. Redundancy is the inclusion in a message of unnecessary, hence noninformative, items. The sequential structure of English involves a high degree of redundancy. Given a certain letter or word (or a sequence of letters or words), the next unit in a message is to a large degree statistically determined. Thus it is possible, in terms of sequential probabilities, to compose combinations of letters (or words) which, while they are meaningless, resemble English.

Although very much concerned with the transmission of messages, information theory pays only indirect attention to meaning. The latter aspect of communication falls in the general area known as semantics. There are three basic problems here.

One semantic problem has to do with the cultural history of word meanings. The point made is that neither the speaker nor the listener is necessarily aware of the full historical meaning of what is said.

The second semantic problem involves the question of how an individual acquires word meanings. This occurs in various ways. At

the beginning, an infant is conditioned so that the sounds made mean the objects or events for which they stand. Later he learns many meanings from verbal contexts, in listening and reading. The learning of concepts (or of categories) is an important part of this process. One erroneous use of categorized meanings is found in the indiscriminate application of labels, like "oriental," without due regard to the varied meanings such words may have in different settings.

The third semantic problem — what processes within the organism represent the meaning of words — has not been solved. Some theories stress images. Others present the idea that responses made to an object are somehow retained in abbreviated form as a link between that object and its name. One thing is certain — that the ultimate basis of meaning is represented in the nervous system.

The semantic differential is used to define word meanings in terms of how they are rated in certain polar dimensions — like weak-strong, good-bad, active-passive. Not all of a word's meaning is represented in this way. Nevertheless, the semantic differential has proved itself a useful instrument in research.

Nonverbal communication is of course communication without words. Much of it utilizes gestures, but we have called attention to a distinction between gestures which represent letters (as in the deaf language) and gestures which, while conventionalized, have no such reference. Pointing would be an example of the latter. Clothing and other objects may also have communicative significance.

(References and notes for this chapter are on page 567 of the Appendix.)

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# Social Behavior

16



Some elementary forms of social behavior • Social facilitation, competition, and cooperation • Status and role • Studying behavior in small groups • The study of "social climates" • Effects of group participation • Group pressures on individual judgment • The study of rumor • Broader aspects of collective behavior • Summary

Man is so much a social organism that any discussion of his behavior which neglected the social aspects would be seriously deficient. But we have not been completely negligent. Consideration of social aspects has entered our discussion at various points, although from a somewhat restricted standpoint. The socially determined nature of behavioral processes has been considered, and language, which is by its very nature social, has had a chapter devoted to it. However, we have not dealt with the interaction process as such. We have not considered how individuals influence each other — as in face-to-face groups and crowds. Now we move to correct this deficiency. Among the topics to be discussed are elementary forms of interaction which characterize the social life of animals, some of which carry over into human social behavior; the status characteristics of human society and the roles that persons play in their social dealings; the behavior of small groups as studied experimentally; group pressures on individual judgment; problems involved in communication of the kind designated as rumor; and broader aspects of social life, including crowd behavior and social movements. In several of these discussions we will also be concerned with problems of leadership.

This is a very broad field which only a course in social psychology could really cover. All that we shall attempt, therefore, is to spotlight a few major issues and representative

experimental investigations. The function of this chapter is thus to provide preliminary orientation in the area of social psychology.

The simplest form of social interaction occurs when the behavior of one organism is stimulated by that of another, as when one animal bares its teeth and the other runs. Imitative behavior (p. 290) is more complicated in that the imitator sets a pattern which the imitator copies, or attempts to copy. However, the behavior with which we are particularly concerned in this chapter involves reciprocal stimulation and response. That is to say, behavior in which one organism stimulates another and is, in turn, stimulated by the other's reaction.

### SOME ELEMENTARY FORMS OF SOCIAL BEHAVIOR

A prime necessity for social behavior is the proximity of two or more organisms. Nevertheless, individuals may be drawn together for nonsocial reasons. And when they are together, they may still not interact. Of many examples that might be given, consider the swarming of insects around a lamp. These organisms are positively phototropic. Their make-up forces them to fly to a source of light. They are individually drawn to this region, and the aggregation is thus purely incidental. Whether the insects influence each other's reactions while in the vicinity of the light is problematical.

At the level of bird life there are further complications. Physiological and climatic changes activate each bird to migrate to its accustomed location. In migrating, however, flocks are formed in which a particular bird may take the lead and in which the behavior of each bird is influenced by that of others. It is in this respect that behavior becomes social.\* In schools of fish and in herds of mammals the same sort of interaction is observed.<sup>1</sup>

To take a further example of how animals may congregate for other than social reasons, think of the various mammals that come together around a water hole in some such place as the African veldt. What brings them together is thirst and the proximity of a water hole. Once there, however, they interact in numerous ways—for example, by mating, fighting, and protecting their young.

It is perhaps unnecessary to point out that

all vertebrates and many invertebrates are born into a social situation where they receive care from one or both parents and in which they interact with their parents and others. Indeed, numerous naturalistic studies of social life in the animal world are largely preoccupied with such forms of interaction as mating, care and provisioning of the young, education of the young, and family organization.

#### Imprinting and socialization

One of the most obvious observations about social behavior is that those of a kind usually stay together—that they have a seeming attachment to (or preference for) others like themselves. It is also clear that this begins very early in life. Consider, for example, such socialization as is evident when ducklings or other young animals follow their mother around.

Under normal circumstances, ducklings and goslings follow their mother soon after hatching, perhaps stimulated by her movements, her vocalizations, or both of these. There is nothing very remarkable about this following behavior, and it would receive no more than passing mention were it not for the fact that, under certain circumstances to be described shortly, the same behavior may be elicited by models, or by almost any perceptible object which moves, including a human being, as illustrated in Figure 16.1. Konrad Lorenz, the German student of animal behavior shown in the illustration, coined the word "imprinting" to designate this sort of attachment of young animals to members of their own or other species, or to models.<sup>2</sup> In one

\* An example given in our second chapter dealt with penguins, whose social organization and interaction is quite complex. (See Figure 2.3, p. 35.)



**16.1** **An Example of Imprinting.** These goslings, which had been isolated from their mother, have learned to follow a human being, in this case Konrad Lorenz, the famous naturalist. (Photo by Thomas D. McAvoy, *Life*. © Time Inc.)

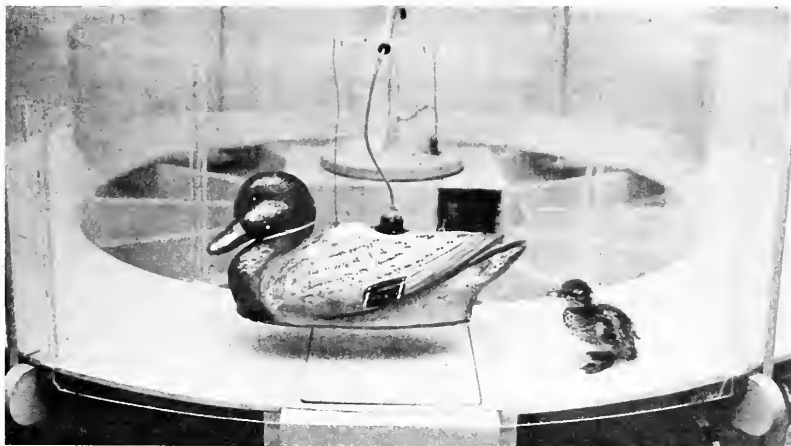
of his most interesting demonstrations of imprinting, Lorenz took a group of goslings that had been imprinted upon him and a group that had been imprinted upon their mother. They were intermingled and placed under a box. The mother and Lorenz stood nearby. Then, as the mother moved away, the box was lifted and Lorenz walked in another direction. The outcome was quite clear, for the goslings imprinted upon Lorenz followed him and the others followed their mother.<sup>3</sup>

It became evident that imprinting upon a substitute for the mother usually occurs only during the first day, and even then, only if the bird has been out of contact with its own mother. Under normal conditions this "critical period" is probably that in which the bird is imprinted upon its mother and other members of the brood.

Once the duckling has come to follow its mother, or anything else on which it is imprinted, the attachment is irreversible. That is, a bird imprinted on a human being does not subsequently imprint upon its mother, or a model, even when opportunities are given to do so. The original attachment thus persists. Moreover, it generalizes to other activities, including sexual approaches toward the imprinting object.<sup>4</sup>

Imprinting has aroused much interest. Investigators have observed something comparable in numerous animals, including sheep.<sup>5</sup> Some have undertaken laboratory investigations designed to reveal the detailed nature of this phenomenon. One such research is described in Figure 16.2 and the accompanying legend, which also summarizes the outcomes.<sup>6</sup>

Some of the interest in this social behavior stems from the possibility that it may have relevance for our understanding of initial stages in human socialization. One investigator<sup>7</sup> says that a child will not develop normally unless it has "a certain amount of attention and handling during a critical period of its infancy. This period is doubtless not as sharply defined as the imprinting period in birds, but it may lie within the first six months of life." The reader will no doubt recall, in this connection, our earlier discussion (p. 149) of the so-called "need for affection" in infants and the attachments of infant monkeys (p. 150) to mother substitutes. All such studies appear



**16.2 An Experiment on Imprinting.** The decoy duck (male mallard) moving around the circular runway is fitted with a loud speaker and emits the man-produced sounds "gack, gack, gack, gack, gack." During the imprinting period (usually less than one hour) the duckling is taken from a box in the incubator and allowed to make a certain number of turns around the runway before being returned. At a later time, in tests for imprinting, it is released halfway between a male and a female decoy model four feet apart. The male is that used during the imprinting period. One minute is allowed for the duckling to respond to either decoy, then sound is turned on in both. The "male" makes the sounds described. The "female" gives the call of a real female. Various responses are recorded—to silent and calling models, stationary and moving models, and so on. If the duckling gives a positive response to the male decoy in all such tests, imprinting is said to be complete (100 per cent). With different groups of ducklings, imprinting is attempted at different times. In general, the results show that imprintability improves until it reaches its peak at 13–16 hours after hatching. Then it declines rapidly with increasing age. At its peak, imprintability is represented by an average score of approximately 85 per cent. For these birds, tested under the conditions described, the "critical period" is thus toward the middle of the first day after hatching. (From Hess, E. H., 6, p. 134.)

to have much in common, but whether the resemblance is superficial or real remains to be discovered.

Imprinting is generally conceded to be a learned response, but of a somewhat special kind. The investigator whose work we have illustrated regards it as

a rigid form of learning, differing in several ways from the usual association learning which comes into play immediately after the peak of imprintability. In other words, im-

printing in our experiments results in the animal learning the rough, generalized characteristics of the imprinting object. Its detailed appreciation of the *specific* object comes as a result of normal conditioning—a process which in the case of these animals takes a much longer time and is possible days after the critical period for imprinting has passed.<sup>8</sup>

Other aspects of socialization have already received attention. We indicated in earlier chapters how basic drives come to be ex-

pressed in socially approved ways, how the child develops a concept of self (ego) and a conscience (superego), how children learn to compete and to cooperate, and how they approach social maturity.

An aspect of socialization not yet discussed is social status. Even in animal groups, there may be a struggle for status, with some individuals dominating others. We say "dominate" because such individuals satisfy their needs at the expense of others and, in face-to-face situations, induce submissive behavior. A good example of such a social relationship is the so-called "dominance hierarchy."

### Dominance hierarchies

The fact that barnyard hens are socially organized was first called to scientific attention by Schjelderup-Ebbe, a Norwegian investigator.<sup>9</sup> He observed that after a group of chickens had been together for some time, a pecking order became established. The most dominant chick pecked all others in the group and was pecked by none in return. The next in line pecked all other chicks except the most dominant, which of course, pecked it. This social order was extended downward until, at the bottom of the hierarchy, there was a

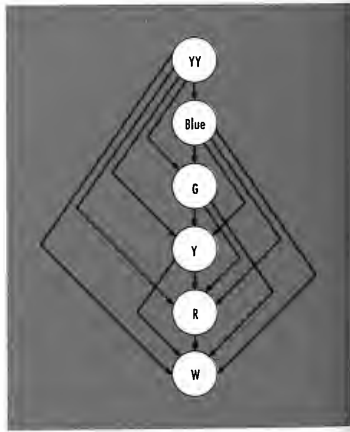
chick pecked on by all and pecking none. A pecking order observed in a repetition of some of Schjelderup-Ebbe's experiments is represented in Figure 16.3.<sup>10</sup>

The pecking order is learned, but how long it takes for a stable hierarchy to develop depends upon the number of chickens involved. One study showed that it took 36 weeks for a group of six to develop a hierarchy like that illustrated.<sup>11</sup> In general, the dominant chicken is the largest, speediest, most aggressive, and most intelligent, as measured by tests of learning ability.<sup>12</sup> This chicken learns that it can win every fight. The one at the bottom of the social ladder finds that it loses every fight. The others, after weeks of fighting, learn which to peck and which to avoid, if possible. As one would expect, the introduction of a new member of the group disrupts the established order. A new hierarchy then develops.

Studies of mammals (including mice, rats, and dogs) show that dominance relations based on fighting are quite common, but that a perfect straight-line dominance like the pecking order of hens is rare.<sup>13</sup>

The author of a recent book on aggression says that children of three and older who have not learned to avoid strangers tend to

**16.3 A Dominance Hierarchy.** Observe that YY pecked on all others, Blue pecked on all but YY, and that W was pecked by all. This straight-line dominance took 36 weeks to develop. All of the birds represented here are barnyard roosters. (Diagram from Murchison, C., 10, p. 22. Photo © Life.)





engage in considerable playful aggressiveness. In many children this is a standard method of getting acquainted with a new child. If unchecked or unsupervised it should theoretically lead to a dominance order based on fighting. From the viewpoint of the cultural ideal of our society, it is desirable that no strong relationships of dominance and subordination be built up between children. No one wants his child to be at the bottom of a dominance order and become the child who is always picked on.<sup>14</sup>

There are doubtless many situations where something approximating a dominance hierarchy based upon fighting (or fear and intimidation) develops among human beings. Notorious examples are found in teen-age gangs.<sup>15</sup> By and large, however, the individual's status in a human group is based upon something more subtle than physical domination—for instance, money or education. In some countries, social status rests upon one's origin. Tradition is also influential.<sup>16</sup> With respect to this, Lady Bowley's prayer, designed for the "lower classes," comes to mind.

O let us love our occupations,  
Bless the squire and his relations,  
Live upon our daily rations,  
And always know our proper stations.

Charles Dickens in *The Chimes*

Interesting as comparisons of dominance behavior in animals and men may be, one needs to observe due caution. The similarities that exist are no more than suggestive. Nevertheless there are some who note the dominance hierarchy in hens, then expostulate on international affairs with this as a basis. Thus a distinguished zoologist, writing on the topic of "The peck order and international relations," had this to say:

... much can be said for an established order of dominance and subordination, whether within groups of non-human animals or among nations. There is growing evidence that with hens, again as an example, well organized flocks, in which each individual knows and is fairly well resigned to its particular social status, thrive better and produce more eggs than do similar flocks that are in a

constant state of organizational turmoil. Similarly among nations, relative quiet exists when the international order of dominance is fairly firmly established and generally accepted. . . . Sooner or later, however, on the international stage as among our groups of mice, or fish, or hens, or other animals, a subordinate always seriously challenges the alpha individual or nation. Although the challenger may be beaten back, often many times, eventually alpha rank is taken over by a new despot, and the cycle starts again.<sup>17</sup>

But this writer renounces the peck order solution of international problems by saying,

in so far as any international organization, formal or informal, is based primarily on the hierarchy of power, as are the peck orders of the chicken pens, the peace that follows its apparent acceptance will be relatively short and troubled. Permanent peace is not to be won by following the precedents established by the dominance orders of vertebrate animals.<sup>18</sup>

Analogies like these are interesting to contemplate, but human societies are different in many important respects from those of animals, even the higher ones. There will be ample evidence of this as we proceed with our discussion of human social behavior.

## COMPETITION AND COOPERATION

One of the most widely observed effects of a group situation on the individual organism is called *social facilitation*. It is often competitive in nature; cooperative behavior is a much higher development.

### Social facilitation

This term is applied when an organism does more in a social situation than when alone. For example, fish eat more when in a group than when eating alone. Ants which dig their nests excavate more dirt, per unit of time, when they work in the group than when they work by themselves.<sup>19</sup> Rats tested alone and in group situations eat and drink more in the latter. It has been shown, however, that facilitation of eating and drinking

occurs only when the situation is competitive — where rats have to take turns at a water spout or where there is a limited supply of food.<sup>20</sup> Social facilitation is also evident in children.<sup>21</sup> Its presence in small adult groups is discussed later.

One can observe competition in many organisms and, as higher levels of animal life are approached, cooperation also enters the scene. These processes are worthy of a more detailed discussion.

In highly organized insect societies, like those of bees and ants, there is no competition. A seeming cooperation is universally evident. Every animal contributes to the common good by performing its special tasks. But this is a cooperation of necessity. Because of its makeup and the situation in which it finds itself, each individual is destined to perform certain tasks and no others.<sup>22</sup> At the vertebrate level of life, however, there is much greater "individual freedom." Here an organism is less bound, socially, than is an ant or bee. It competes with others for the necessities of life, thus eats and drinks more in a group situation.

A truly cooperative type of behavior — one not predetermined biologically, as in insects — is sometimes observed in laboratory experiments with rats and higher mammals. Naturalists have reported many examples of "mutual aid" among animals ranging from birds to the higher apes,<sup>23</sup> but we will confine our attention to some typical laboratory investigations.

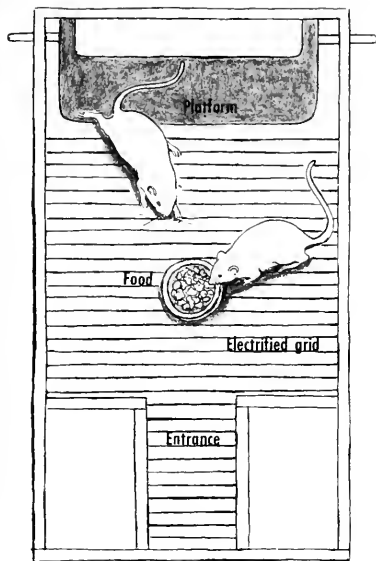
#### Experiments on cooperative behavior

Something suggesting cooperative behavior emerged from an experiment in which rats were trained to operate a lever, each movement of which caused a small pellet of food to become available, as in the operant conditioning situations with which we are already familiar (pp. 276–277).<sup>24</sup> After this response had been established, the experimenter placed the lever and the food trough at opposite ends of the experimental box. This meant, of course, that the operator had to travel a short distance before he could get his reward. The next step was to place three appropriately conditioned rats in the same box. In this situation the operator usually failed to get his re-

ward. When the food trough was reached, another animal had already eaten the pellet. Initially all three animals did some pressing and the operator, upon reaching the trough, fought with the others for food that was no longer there. Finally, one rat found a solution. It pressed the lever several times in rapid succession, so that there was usually some food left when it reached the trough. On the other hand, its associates eventually learned that they needn't work at all. They stayed near the food trough and ate food pellets as these became available. A "class society" consisting of one worker and two parasites thus emerged. We cannot say, however, that one rat actually cooperated with the others. The worker had merely solved its own problem — how to get food in this situation. Benefit to the others was purely incidental.

What appears to be a genuine example of cooperative behavior occurred in another experiment, also with white rats.<sup>25</sup> These rats, unlike the above, did not need to compete. The general situation is illustrated in Figure 16.4. It comprised a box with an electrified floor, a platform which turned the shock off when a rat held it down, and a crock with a plentiful supply of food. The platform was located away from the food supply. Each rat first learned, individually, to eat food from the crock; then, when the floor was electrified, to turn off the current by stepping on the platform. Finally, rats were paired, as illustrated. Would they learn to cooperate, with one depressing the platform while the other ate? At first the rats either ate at the same time, both getting a shock while doing so, or they sat on the platform together with neither of them getting anything to eat. In the case of some pairs, however, cooperation eventually developed. Their behavior became directed toward each other. One rat fed while the other was on the platform, then the latter made various responses toward the feeding animal, such as biting its tail or pulling on it until this animal returned to the platform. Eventually the rats shuttled back and forth, both getting food and both avoiding most of the shock.

Cooperative behavior of a high order has been demonstrated in chimpanzees. In an experiment already described (p. 433), pairs of chimpanzees learned to pull together so that



**16.4** Device Used to Study Cooperative Behavior in Rats. As described in the text neither rat received a shock while the other was on the platform. They learned to take turns at the food crock and the platform. (Adopted from Daniel, W. J., 25, p. 362.)

food was brought within reach. When one member of a pair failed to get needed cooperation, it touched the other animal on the shoulder, turned it around, and, in fact, seemed to be "saying" something like "Help me." Similar results were found in a situation of still greater complexity.<sup>26</sup> Here two chimpanzees were in separate cages. Each cage contained two colored panels — for example, one cage a yellow and a red panel and the other a green and a blue. Food became available only when the panels were operated in a given sequence — say, *yellow, green, red, blue*. This meant that one subject, after pushing *yellow*, had to wait until its partner pushed *green*. This ani-

mal, in turn, had to wait until *red* was pushed. When *blue* was pushed, both got the reward. Some chimpanzees watched their partner and solicited when he was slow to respond. They reached through the bars, turned him in the right direction, or pushed him. However, there was no pointing toward the correct panel.

Cooperative behavior in human beings is of course greatly facilitated by pointing and by speech. In a situation which somewhat resembled the chimpanzee experiment, one preschool child got the other to help her by pointing or by saying "Look at that," or "Pull that string."<sup>27</sup> Another experiment required each child of a pair to put a stylus in a corresponding hole at the same time.<sup>28</sup> When each put his stylus in the proper hole, a jelly bean was obtained. This part of the experiment was relatively easy. But one jelly bean could not very well be divided. So the question arose as to which child was to get the jelly bean for their coordinated efforts. This dilemma was settled verbally, usually by a decision to alternate — "The first jelly bean is mine, the next is yours," or something comparable. This sort of cooperation foreshadows the "deals" which follow childhood and which play so important a part in human affairs at every level of activity.

The preceding discussion of elementary forms of social behavior has served three purposes. In the first place it has given explicit meaning to the term "social interaction." Secondly, it has demonstrated some of the techniques used by psychologists and others to investigate social behavior in animals and children. Finally, it has provided a background against which we can project our discussion of social interaction in adult human society.

### STATUS AND ROLE

An individual's *status* is his position in a social system. In a barnyard, this is simply a matter of relative position in the pecking order. Human society is so complex, however, that status varies, depending upon the particular angle from which we view it. From a broad political standpoint, there is the status of President, cabinet member, congressman, governor, and so on. Overall, our society has a discernible "class structure." We speak of a person's status as being, for example, *upper*,

middle, or lower class.\* Overlapping this structure, but with a somewhat intellectual reference, a person may be referred to as "highbrow," "lowbrow," or somewhere in between these levels. Another frame of reference is socio-economic. One's status, from this standpoint, may be *professional, business, skilled laborer*, and so on. Some have a degree of status as "white collar workers." There are frequently status implications in being of a certain race, nationality, or religion. Within a much narrower scope are such statuses as *infant, child, adolescent, college student, female, wife* or *parent*. There are also status positions within small established groups, such as a club or athletic team.<sup>29</sup>

But there is much more to status than we have suggested. With a given status there is usually a certain "style of life." Class status, for example, has associated with it certain so-called "status symbols," involving the kinds of cars driven and clothes worn. Class status is also related to the educational level attained and the content and manner of speech.<sup>30</sup> According to Kinsey, such differences extend into the sex life.<sup>31</sup> Of greater interest, from a psychological standpoint, is the fact that different statuses require the playing of different roles.

The analysis of social behavior from the standpoint of roles is worthy of special attention. There are many definitions of the term *role* and there have been many theoretical discussions and practical applications, such as role-playing in psychotherapy and in the training of business and industrial leaders. Here we can consider no more than a few basic aspects of this concept.<sup>32</sup>

The role played by an actor has no reference to his status, except that of "actor." In everyday life, on the other hand, role and status are inseparably linked. As one writer has so succinctly phrased it, "the term *role* centers around the organized *actions* of a person coordinate with a given status or position."<sup>33</sup> This writer and others have pointed out that the person in a particular status situation is expected to act in certain ways and, in turn, expects others to reciprocate.

\* Vance Packard's *The Status Seekers* (McKay, 1959) is concerned with what we are discussing, but from the standpoint of the devices which individuals use to enhance their status.

## Acquiring roles

An important aspect of every instance of role acquisition is learning to "put oneself in the place of others" — to *identify* with them — and, as Robert Burns put it, "to see ourself as others see us!"

A child learns to identify by role-playing, copying the behavior of others, and receiving instructions as to the proper behavior for "little girls," "little boys," and so on. The little girl plays with her dolls — now the role of mother, now that of doctor or nurse. She may also take the part of her doll in conversation, as when, after telling her "baby" to stay in its crib, she steps into the other role and says, "But Mummy, I don't want to stay in my crib." A comparable process is often involved in the development of conscience. A boy may even step into the role of father and admonish himself for doing what his father has forbidden.

In time we normally become adept at changing from one role to another, as each new situation arises. In each instance, the role is one dictated (in part, at least) by status. Thus the teacher plays a different role in the classroom from the one he enacts on the golf course, or in his home. In the classroom a student, in accordance with the teacher's status and his own, expects the former to lecture, for example, while he takes notes, and to give examinations while he answers them. If the teacher is also a graduate student, he will, on appropriate occasions, play the student role. And so it is with the many interlocked roles which people play in everyday life. As one's situation (and his status) changes, he may be said to assume different roles. Some would say that he exhibits different "selves," for there is a very close relation between one's self (p. 250) and the well-established roles of his everyday life.<sup>34</sup>

The shift from one role to another, or the actions involved in a particular role, are usually not calculated, nor is an individual necessarily aware of his role-playing, as a stage actor is. But there are instances, as everyone knows, where a person "tries to make an impression," and so obviously that we refer to his behavior as an "affectation" or to him as "affected." In most instances, however, each of us becomes so conditioned as to play appropriate roles unthinkingly.

An interesting sidelight on the interplay of status and roles is the modern tendency (in our society) to upgrade roles of low status by giving them a face-saving label. Thus the janitor may become a "custodian" and the street cleaner a "sanitary engineer."

In addition to well-established roles there are others that may be thrust upon us. The hero's role is of such nature. In a group situation where there are problems calling for solution, an individual emerges as the leader. Some of the OSS tests described in an earlier discussion (p. 243) involved leaderless groups that were given a problem to solve. In these tests, individuals were observed to see what role each would play. Roles which emerge in such face-to-face situations are involved in later discussions.

### Role conflict

Although each of us plays multiple roles in this complex society of ours, role conflicts, even when they exist, seldom bother us. The person whose religious affiliations are in conflict with a role he plays in everyday life tends to rationalize the discrepancy, so that the inconsistency that others may observe, causes him little concern. During the last war, by contrast, many young men experienced an intense conflict between their role as followers of the "Prince of Peace" and their role as loyal citizens of a country at war. This role-conflict could not be solved by any such formula as "Praise the Lord and pass the ammunition."

Studies of behavior in situations involving disaster have shown that, under such conditions, one role may take priority over others with which it is now (perhaps for the first time) in conflict. Following a disastrous explosion in Texas City, for example, people whose duty it was to stay on the job and fight the fire rushed to their families instead, to see if these were safe, or to help them. A clergyman, who started to aid in rescue work, realized that it was more important for him to comfort the families of those who were killed, so he resolved to fill the latter role.<sup>35</sup> What is involved in all such situations is a conflict not merely of roles, but at the same time, and from a somewhat different slant, a conflict of obligations and loyalties.

Early experimental studies with small groups of human subjects dealt with social facilitation, the phenomenon already referred to as evident in animal behavior. The human subjects of experiments in this area engaged in activities like crossing out letters (e.g., every *e* on a page), tapping as fast as possible, and adding or multiplying. Sometimes they worked alone and sometimes as members of a co-working group. The latter was not, however, a cooperating group. We will discuss such groups later.

In one type of comparison, more subjects made their highest scores in the group situation — as compared with that in which they were merely working by themselves. Another type of comparison revealed a higher average output in the group than in the isolated situation. Further research of this nature showed the facilitating effect of group activity to be due, in large measure, to conscious or unconscious rivalry. For example, when individuals working in groups were told that their scores *would not be compared*, the facilitating effect of group situations failed to appear. In other experiments each person worked alone, but was told that his score *would be compared* with the scores of others working at the same time in separate rooms. Now the amount accomplished did not vary from that found in a group situation. Thus, as in the case of animal studies, social facilitation was reduced to "competitive effort."<sup>36</sup>

Studies like the above also demonstrated certain adverse effects of group situations, especially where competition was keen. There were individuals who became flustered and incoordinated under group conditions, hence did more poorly than when working alone. An example of this can be seen in the simulated horse race where wooden horses on individual tracks are pulled with strings wound onto fishing reels. At the signal, an individual starts winding on his reel as fast as possible. In a practice situation, working alone and noncompetitively, there is normally a smooth performance. But in the "horse race," under keen competition to have one's horse come in first, there is often a marked incoordination,

such as reversing the reel and tangling the line.<sup>37</sup>

Another adverse effect often noted in comparisons of individual and group performance is an excess of errors under the latter condition. This is prone to show up in arithmetical work. Thus the speed-up in a group situation may be offset by a lower quality of work than when individuals work alone.

Current research on small groups is not so much concerned with the output and quality of performance as with the nature of social interaction; i.e., with interpersonal relations. We are ready to consider now some typical studies in this general area, which is often referred to as "group dynamics," a term introduced by Lewin (p. 209) to stress the dynamic, as opposed to static, characteristics of groups. This viewpoint is well represented by his statement that

The essence of a group is not the similarity or dissimilarity of its members, but their interdependence. A group can be characterized as a "dynamical whole"; this means that a change in the state of any subpart changes the state of any other subpart. The degree of interdependence of the subparts of members of the group varies all the way from a "loose" mass to a compact unit.<sup>38</sup>

Many methods are used to study interpersonal relations, but we confine our attention to four. The first of these is a *social field analysis* of the type which led Lewin to speak of "group dynamics" before this term came to be more generally applied. Next we illustrate how intergroup relations may be studied by sociometric procedures. We then describe a method now widely used to record interaction in small groups while it is in process, the procedure referred to as *interaction process analysis*. Finally, we consider studies of collective problem-solving, some of which compared the efficiency of different communication networks.

### Social field analysis

This involves concepts which defy an adequate brief discussion. Nevertheless we give them in essence and then discuss their use by Lewin in analyzing a relatively simple group

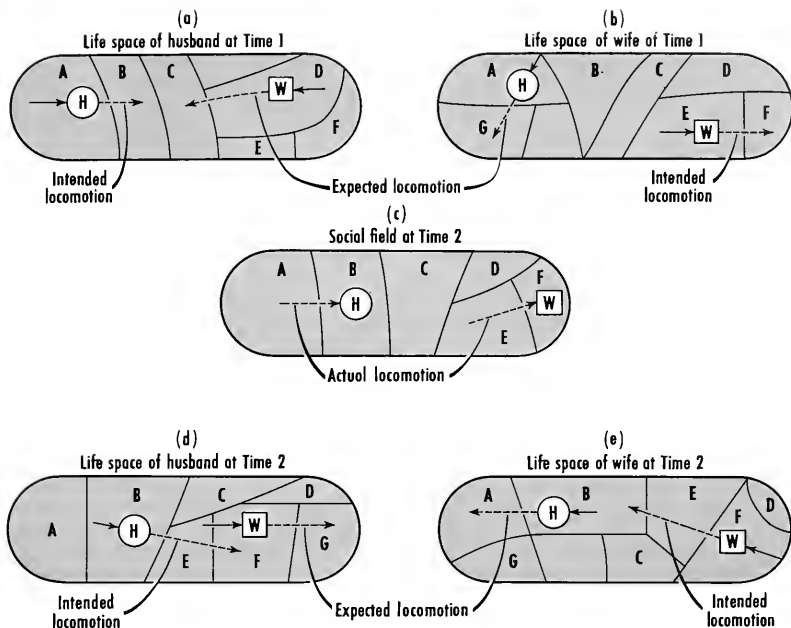
situation, involving a husband and his wife.<sup>39</sup> The concepts in question are *life space*, *social field* and *locomotion*.<sup>40</sup>

*Life space* refers to the individual and his environment *as perceived by him*. Lewin and others have pointed out that there is a marked difference between the environment (geographical) as a physical scientist might view it and the environment (psychological) as the behaving person views it. We had such a distinction in mind when we said in an earlier discussion (p. 73) that two individuals in the same objective environment could be in very different environments psychologically.

The *social field* has reference to other people, or to what was referred to earlier as the "social environment." However, Lewin's concept of social field involves not only the actual presence of other persons, but also their symbolic presence, as when thinking of your mother's reaction to what you are contemplating either encourages or discourages you from going ahead with your plans. In the following example of social field analysis, the wife pictures her husband as doing certain things even though he is not present. Although absent, he is still part of her social field, as this is conceived of by Lewin. The life space includes the social field (as the individual perceives it) as well as the broader environment (again as the individual perceives it.)

In ordinary terminology *locomotion* is merely moving from place to place. As Lewin uses the term, it includes symbolic (expected, anticipated, intended, imagined) locomotion as well as an objective change of position.

Now we are ready to consider the type of social field analysis represented in Figure 16.5. The complete outer boundary of each diagram represents the limits of the individual's life space at the moment; i.e., Time 1 and Time 2 as indicated. The inner regions are conceived of, not as different parts of objective space, but as possibilities of action, even at the symbolic level, as when a person reaches a decision, moves from one attitude to another, and so on. First the life space of the husband (H) is analyzed; then that of his wife (W). In the first diagram we see the respective positions of (H) and (W). In terms of their situation as (H) views it (including what he knows, or thinks he knows about (W)) he intends, let us say, to move



## 16.5 A Marriage Problem. These diagrams represent the life space of, respectively, a man and his wife as conceived by Kurt Lewin and described in the text. (From Lewin, K., 39, p. 196.)

from region A to region B. It is assumed, here, that the social analyst has enough information about (H) and his situation to predict this. Likewise, in view of the situation as (H) perceives it, he expects his wife to move from D to C. All of this is represented in diagram *a*. Diagram *b* involves a comparable analysis from the wife's point of view, that is to say, from the standpoint of her own life space. Again it is assumed that enough is known about these two people to fill in the details which represent this. Note that her life space shows a marked contrast with that of her husband. It is quite differently structured. Moreover, her expectation, in terms of what she knows (or thinks she knows) about her husband is that he will move from A to G. She intends to move from region E to region

F. Actually, as shown in diagram *c*, (H) does move to B (which means that he may reach a certain decision, change from one attitude to another, or even move physically from one place to another—a different house, for example). Likewise, (W) is shown in the same diagram as having moved to F. Lewin says,

Neither husband nor wife had expected their partner to behave as he or she actually did. Obviously, the next step will depend largely on how each will react to this surprise, how each will interpret the conduct of the other, or, more generally speaking, how each will "perceive" the new situation.

The husband who has expected his wife to move from D to C and now sees her moving in the opposite direction, to F, may interpret

this to mean that his wife has "changed her mind." In this case he may expect her next move to proceed in the same direction, namely toward C [as in diagram *d*]. Furthermore, the behavior of his wife is likely to change for him the meaning of C, that is, the cognitive structure of the situation. The wife who sees her husband move to B rather than C may perceive this to be an excursion to an activity which would be completed in a certain time after which he would return to A [diagram *e*]. She therefore decides to join her husband in B, whereas her husband, having a different perception of the situation [diagram *d*], intends to move on to F, which he perceives as being closer to his wife.

Obviously, husband and wife will soon be in trouble if they do not "talk things over," that is, if they do not communicate to each other the structure of their life spaces with the object of equalizing them.<sup>41</sup>

Enough has been said about social field analysis to illustrate how it goes at the task of trying to understand and predict social interaction. To an investigator well versed in its use, this type of analysis no doubt helps to clarify his thinking about the intricacies of particular interaction problems. Lewin and others have found it of practical value in industrial and other situations.<sup>42</sup> What we can get out of this discussion is an appreciation of the fact that interactions are not based upon the objective facts alone (as, say, a motion picture, even with sound track, might portray them) but upon how they are perceived (or interpreted) by interacting individuals, and each in his own way. This type of analysis is an attempt to unravel a basic human relations problem, but a problem that is extremely difficult to study. Beyond individual relationships, as in the relatively simple illustration that we have used, the same sort of problem arises in intergroup relations—labor and management's view of each other, the Russian view of us, and our aims, and our view of them and their intentions.

#### Sociometric procedures

The sociometric study of interpersonal relations also has reference to how interacting individuals view each other, but in a somewhat

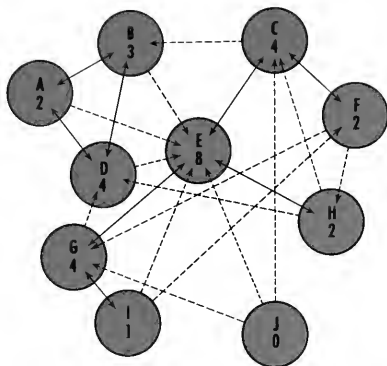
more limited sense than the approach already considered. There are several procedures, but they have in common the fact that individuals are asked to nominate, from among other members of their group, the member with whom they would most (or least) like to live, go on a mission, or carry out some project.<sup>43</sup> The individual who nominates is assured that his selections are confidential. Among a group of children, for example, each might be asked to tell, in private, the name of the child he would most like to have with him on a hike, or to share his tent. Military personnel, on the other hand, may nominate members of their group to accompany them on a combat mission. College students have been instructed to "Indicate the person whom you would most like to have as a loyal friend" and to "Name the person with whom you would most like to attend a formal affair." Sometimes the individual nominates whom he would *most* or *least* like to have associated with him in one or more activities and that is all, but some procedures require him to rank members of his group from the most to the least preferred.

The *sociogram* is a graphic representation of interpersonal preferences. It shows the status of each member of the group in terms of his acceptance or rejection by other members. A somewhat simplified sociogram for a group of ten persons is shown in Figure 16.6. Observe, for example, that A and B are attracted to each other—i.e., each chooses the other. I chooses G, E, and F, but is, in turn, chosen only by G. The numbers represent votes received, as described in the legend. E, who received more votes than anybody else, is the "star." J, who received no votes, is an "isolate."

Sociometry of the kind described has been widely used to select individuals for certain group projects, to discover isolates with a view to improving their social relations, to identify leaders, and to study group morale, which is likely to be high when members of the group are mutually congenial, as in the case of A, B, and D of our illustration.

Since the usual sociometric analysis involves a relatively simple procedure and an outcome which lacks very precise quantification, efforts have been made to improve upon it. One example is an extensive study of social relations





## 16.6 Sociogram of a Group of Workmen.

Each person, represented here by a letter, was asked to vote for the three men most desired as working companions. Numbers represent votes. Thus E received 8 and J received no votes. Solid lines represent mutual choices. A and B, for example, voted for each other. Broken lines indicate one-way choices. J, for instance, voted for E, G, and C, but they did not select him. The person voted for by most (that is, E) is designated in sociometric research as a "star." J, on the other hand is an "isolate." (From Maier, N. R. F., *Psychology in Industry*, 2nd Ed. Houghton Mifflin, 1955, p. 130.)

and morale in nine fraternity groups at Syracuse University.<sup>44</sup> The procedure and the quantification of results are too detailed for adequate presentation here. Nonetheless, the general approach can be indicated.

Cognizance was taken of the fact that an individual might select different associates, depending upon his psychological need at the time. For example, a need for moral support in a difficult situation, for someone to have a good time with, or for someone to confide in. Therefore, each student made his nominations with reference to particular needs, which were indicated and elaborated upon by the investigator. The data were gathered in private interviews during which each student was assured that the investigator would hold his selections in strict confidence. He was asked not to tell anybody else about them. A

normal distribution curve (Figure 16.7) was shown, but without the names that appear in our figure, the meaning of which will soon be indicated. The curve was explained and the student asked to think of it as representing all males he had ever known. The subsequent instructions were:

Let us suppose that among your acquaintances there are people with whom you like to maintain a loyal friendship. You may be uncertain as to why you are attracted to such persons, but you know that being in their company on almost any occasion tends to give you a good feeling.

The interviewer then pointed to the curve and said:

Choosing from this group of people and with this situation in mind, *who BEST fits this description?* That is, with what person would you most like to maintain a loyal friendship? What is his name?<sup>45</sup>

The answer may have been, "Egan." Egan's name was then put at the extreme right of the curve, as illustrated. Following the same general procedure, it was ascertained that Adams *least* fitted the description, that Clark would be *average*, that Drake would fall half way between Clark and Egan, and so on. All of this was to establish reference points so that the student could rate his fraternity brothers in a comparable fashion.

Without going into details of the procedure, we can note that each fraternity brother was placed in one of eight categories, defined by divisions on each side of the midpoint of the distribution curve, as indicated in our figure. It was in terms of these segments that scores (ratings) were assigned. Thus Bill Smith, being placed in the same segment as Egan, would be scored 8 and John Jones, falling in the same segment as Adams, would receive a score of 1.

With their data quantified in this way, the investigators were able to obtain information on how well an individual's social needs are satisfied within his fraternity, the social-relations status of particular fraternity men, and the level of morale in one fraternity as compared with another. Sociometric data were

also studied in relation to such outside indices as general satisfaction or dissatisfaction with fraternity accomplishments on the campus.

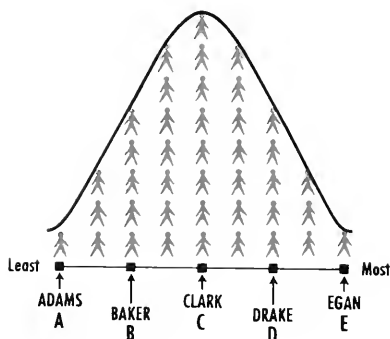
This refinement of sociometric procedure has been demonstrated to have value in studying one type of small group, namely, a fraternity. It will no doubt now be extended to other small groups, possibly in industry and the armed services.

### Interaction in process

Interaction process analysis focuses upon individuals interacting in a temporary problem situation, hence it deals with interaction that is much more casual than that discussed in the preceding sections. This approach has nevertheless revealed some interesting facts about interaction during cooperative problem-solving.

Observations are carried out in a laboratory setting, with a small group of students working in a room while being observed through a window with one-way vision. Each member of the group is informed that reactions are to be observed and that a sound recording of everything said will be made.<sup>46</sup> The general situation is shown in Figure 16.8.

Observers who are trained for their task use



## 16.7 Normal Curve with Anchoring Points.

The use of this figure has been described in the text. Clark is in the position designated "average." (Modified from Gardner, E. F., and G. G. Thompson, 44, pp. 32-33.)

a code to record every act (verbal or otherwise) on the moving tape of a special recording device. Thus the acts of each individual (and their timing) are recorded. The code involves twelve response categories which investigators have found to be adequate for the purpose. These are: shows solidarity, shows tension release, shows agreement, gives suggestion, gives opinion, gives information, asks for information, asks for opinion, asks for suggestion, shows disagreement, shows tension, shows antagonism.

Different observers show a high degree of correspondence in what they record. The reliability of the data obtained has thus been established.

The standard task was to resolve a problem in human relations. Each member was given an identical written report of the facts in the case, but without knowing that his partners had the same information. These reports were read prior to the beginning of the group session and returned before it began.

The nature of the interactions taking place in such a session as we have described, as well as an idea of how trained observers categorize different individual acts, may be gathered from the following:

*Member 1:* I wonder if we have the same facts about the problem? [Asks for opinion.] Perhaps we should take some time in the beginning to find out. [Gives suggestion.]

*Member 2:* Yes. [Agrees.] We may be able to fill in some gaps in our information. [Gives opinion.] Let's go around the table and each tell what the report said in his case. [Gives suggestion.]

*Member 3:* Oh, let's get going. [Shows antagonism.] We've all got the same facts. [Gives opinion.]

*Member 2:* (Blushes) [Shows tension.]<sup>47</sup>

The relative frequency of the twelve types of interaction, derived from 24 different groups which varied in size from two to seven members, is shown in Figure 16.9. This comparison is based upon problem-solving of the sort described above.

It is apparent that the giving of opinions occurred most frequently, comprising 30 per cent of the acts recorded. About 56 per cent of the total reactions were classifiable as

problem-solving attempts: that is, "gives suggestion," "gives opinion," and "gives information."

One interesting outcome of investigations like that described is what they reveal about leadership in such small problem-solving groups. A member's talkativeness is one important leadership variable. Two others are ratings by the group members of each individual's task-ability (how well they think he contributed) and his likeability.

It has been found that relatively few individuals rate high on all three variables. More have high ratings for talkativeness and task-ability and a lower rating for likeability. This type of leader is referred to as the "task specialist." Still more familiar is the so-called "social specialist," the individual who rates high on likeability but relatively low on the other variables. A person who is high on talkativeness, but low on task-ability and likeability, is referred to as an "overactive deviant." He attempts to dominate rather than lead. Then, of course, there are those who rate low in all three respects — the so-called "underactive deviants," or "scapegoats."<sup>48</sup>

What we have described is actually an oversimplified version of the findings on leadership in small groups. It has been observed that while some individuals rather generally exhibit the same sort of leadership in differently composed groups, in groups of different size, and in groups focused on different kinds of problems, others show considerable variability from one setting to another. Some lead in certain situations and not at all in others. In

short, as one investigator has put it, observation of behavior in small groups

strongly supports the contention that leadership is not an attribute of personality or of character. It is a social role, the successful adoption of which depends upon a complex of abilities and traits. But even more, the adoption of a leadership role is dependent upon the specific situation. The same individual in the same group may alternate between the role of leader and follower as the group goal changes. Most frequently the individual is propelled into a position of leadership by virtue of his capacity for interpersonal contribution in a specific situation.<sup>49</sup>

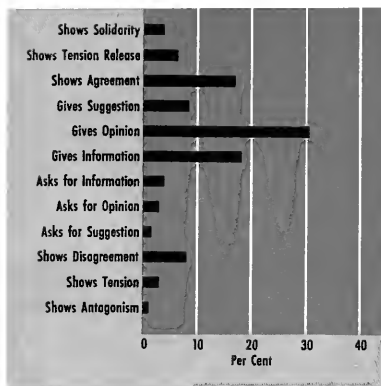
Here we have focused upon the method known as *interaction process analysis* and illustrated how it is used to study the emergence of leadership in small problem-solving groups. What has been emphasized is the interaction process — not the efficiency of group versus individual problem-solving nor the question of how group problem-solving can be most efficient. We now consider collective problem-solving from these standpoints.

### Collective problem-solving

Outcomes of studies on differences between collective and individual problem-solving have varied, depending upon the nature of the problems, the amount of information available to each individual, and the composition of the groups. In the above studies on inter-

**16.8 Observing and Recording Interaction in Process.** Observers trained to record interaction in terms of the twelve categories described in the text observe a small problem-solving group through a one-way vision mirror. In this instance the task is a chess problem. (Courtesy Dr. Robert F. Boles.)





**16.9 Types of Acts Studied in one Type of Research with Small Groups.** Observe that the act "gives opinion" comprises about 30 per cent of the total acts in the type of conference group with which we are concerned. (From Bales, R. F., "How People Interact in Conferences," *Scientific American*, 1955, 192, 33.)

action process analysis, every individual had all of the information available. The main advantages of this group situation were: (1) some individuals had more ideas than others and (2) any individual's ideas were subject to criticism from others. Any idea thus received an evaluation which the individual (working alone) might not have given it.

Problems of the "brain teaser" variety have also been used to compare collective and individual performances. In some studies the group has achieved more solutions; in some, the individual; and in others, there has been no difference.<sup>50</sup> A recent review of such studies leads to the conclusion that, in general, collective problem-solving is relatively inefficient. This means that, in terms of *time per person* to achieve a solution, the individual does better to work by himself.<sup>51</sup>

Our discussion of collective problem solving so far has dealt with problems involving information available to every subject, whether working in a group or alone. But how about problems which require a pooling of informa-

tion, only part of which is known to each individual? Under these circumstances, several heads are obviously better than one. This may also be true when solution calls for creativity and some individuals in a group are more creative than others.\*

Whenever individuals have specialized information and attempt to solve a problem by pooling it there are communication problems.<sup>55</sup> This fact led to the following relatively simple investigation. In a given experiment there were five subjects, each with information that the others did not have. This appeared on a card containing five symbols of which those in Figure 16.10 are typical. Note that six symbols were involved in the problem. One subject, designated "White," had the triangle missing and his five symbols included a cross. "Red" had no diamond, but his card contained a cross. The asterisk was missing from

\* The so-called "brainstorming" procedure is relevant here.<sup>52</sup> This is a group discussion designed to generate creative ideas. Its originator (an advertising executive) claims that brainstorming produces more ideas than come to individuals working alone. But an experimental investigation<sup>53</sup> with Yale University students has shown that this is true only if each individual is compared with a group (of four in this case). When the comparison is between four individuals working alone (nominal group) and a comparable group of four individuals working as a group (actual group), the former have more ideas and better ones. It has nevertheless been claimed that "The theory underlying brainstorming seems, in the light of available evidence, to be sound. The general purpose is to produce intercommunication of as wide a range of ideas as possible. The main procedural rule is that criticism and evaluation of both one's own ideas and those of others are to be withheld (until some time later). A 'free-wheeling' attitude is encouraged as is also 'taking off' from other persons' ideas."<sup>54</sup> In the negative research with college students there was apparently a tendency for the brainstorming procedure to *inhibit* creative thinking. Moreover, the subjects often fell into similar trains of thought, thus reducing the number of unique ideas. It may be argued, of course, that college students are more sensitive to criticism by their peers and thus greater conformists than business men. On the other hand, it has been demonstrated that special training of college students in "brain-storming" techniques leads to significant increments in creative problem-solving. See Meadow, A., and S. J. Parnes, "Evaluation of Training in Problem Solving," *J. Appl. Psychol.*, 1959, 43, 189-194.

Six Symbols Used: ○ △ ◇ □ + *						
Trial No.	Symbol Missing From:					Common Symbol
	White	Red	Brown	Yellow	Blue	
1	△	◇	*	○	□	+
2	◇	○	□	△	+	*
3	+	*	□	△	◇	○
4	□	◇	△	*	+	○

**16.10 Typical Symbols of the Problem on Communication Networks.** It will be seen that each subject, in a given trial, had one symbol missing. This was a different one for each of the five subjects. The missing symbol was, in each case, replaced by one which they all had in common. (Fram Leavitt, H. J., 56, p. 40.)

"Brown's" card, which also had a cross. Thus every card included among its five figures one that was common to all. The problem was: "which is the common figure?" Quite obviously, the members of a group had to share their special information.

In separate experiments, with different subjects each time, the five communication networks shown in Figure 16.11 were tested. In the circle, any individual could give information to the person next to him. This was done by writing on a slip of paper and passing it along the communication channel symbolized

by the connecting line. In this way, information passed around the circle until some subject named the common figure. In the wheel, on the other hand, A could pass information to C, but to nobody else. C could pass it on to B, E, or D as he saw fit. These could pass it on only by sending it back to him.<sup>56</sup>

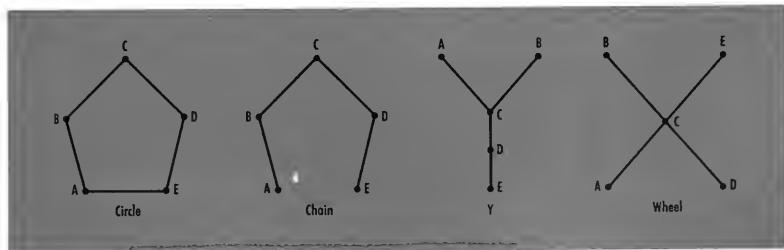
The outcome of this experiment was quite clear. A wheel network was consistently shown to be most efficient and a circle least efficient. The wheel groups, for example, obtained correct solutions in the shortest time, required the fewest total number of messages, and made the fewest errors.

The individual in the center of such a network has a position of leadership from the start. Upon receiving information he can decide where it will do the most good, hence where to send it next. This no doubt contributes to the greater efficiency of the wheel network.\*

We now continue our study of interpersonal relations in small groups. Leadership is again involved, but a leadership imposed upon the group rather than one emerging within it.

\* These results cannot be generalized to all situations. Communication networks in business and industry involve special problems and each must be evaluated in terms of specific situations. The investigator whose research we have discussed has written a book dealing with these special problems. See Leavitt, H., *Managerial Psychology*. University of Chicago Press, 1958.

**16.11 Same Communication Networks.** As described in the text, each individual could communicate only along the channels represented by solid lines. In the wheel pattern, for example, nobody could communicate with anybody else except through C. (Fram Leavitt, H., *Managerial Psychology*, p. 42.)



## THE STUDY OF "SOCIAL CLIMATES"

One of the most widely known types of experimentation in the general area of "group dynamics" is that in which small groups are subjected to different kinds of leadership and their subsequent behavior analyzed in terms of group productivity, morale, and attitudes of members toward the leader and each other.<sup>57</sup> Experiments of this nature have been carried out with boys formed into after-school clubs for specific projects requiring group participation. In one set of experiments, for example, papier mâché theatrical masks were made. Several groups, each composed of five ten-year-old boys, were used. The groups were equated in terms of socio-economic status and other variables, including previous interpersonal relations, as determined sociometrically. Leadership was given by adults who were trained to lead in three ways — authoritarian, laissez-faire, and democratic as called for by the experimental design. The leadership was so designated, not in terms of political structures thus categorized, but from the standpoint of the specific roles assumed by the leaders. The *authoritarian leader*, for example, determined all policies, dictated the nature of every project, and criticized but refrained from active participation. The *laissez-faire leader* was that in name only. Each member of the group was given complete freedom to do anything he wished and the adult neither participated nor gave information, unless this was requested. The *democratic leader* called for a discussion of policies. He suggested possible goals and procedures, but these were actually selected as an outcome of group discussion. This type of leader also participated as a member of the group and commented upon activities from time to time, but in an objective or "fact-minded" manner. Each group worked on similar projects under different kinds of leadership and the same adult rotated from one group to another, in each case assuming the leadership role which the design of the experiment called for. Thus, in a particular experiment, one group might begin with a democratic leader, six weeks later work on a comparable project with an authoritarian leader, then, after another six weeks, change to a comparable project with a laissez-faire leader. Another group would reverse this

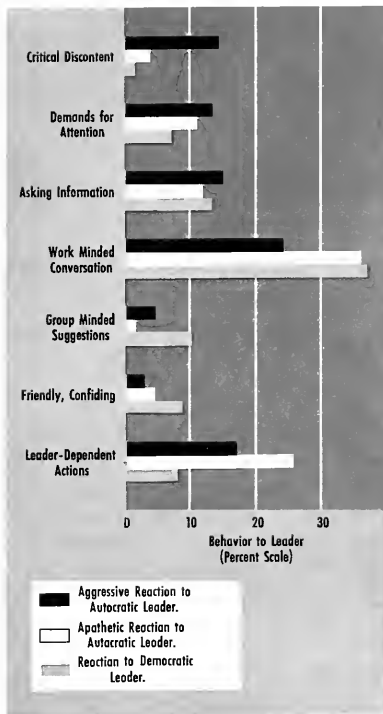
process, beginning with an authoritarian leader. The rotation procedure assured that each club would work under each kind of leadership, and with a different leader each time a change occurred.<sup>58</sup>

The "group climate" or "group atmosphere" differs considerably depending upon the sort of leadership involved. Little of a favorable nature can be said for laissez-faire leadership as compared with the other two types, hence we will compare only the democratic and autocratic "climates." In some respects the autocratic situation tended to be superior — the boys who accepted it submissively worked for longer stretches, and of course got more done. But this was only while the leader was present. When he absented himself "the boys in democracy kept right on working . . . while in autocracy when the leader left, the boys stopped working as if glad to be relieved of the task they 'had' to do."<sup>59</sup> There appeared to be more originality in the democratic situation and also less hostility (toward the leader and other boys), and less aggression.

Recent research along similar lines has verified the findings described and has revealed additional details.<sup>60</sup> One of these is the fact that authoritarian leadership is conducive to apathy in some groups and aggressive resistance in others. We see in Figure 16.12 that the detailed outcomes of an imposed autocracy differ, depending upon the passive or aggressive reaction to it. Note, for example, that groups reacting aggressively to autocratic leadership were more discontented than those reacting passively. They also made more demands for attention and asked for more information. On the other hand, both the passive reactors and the democratic groups engaged in more work-minded conversation than the aggressive reactors. Other comparisons will be evident in examining the figure.

## EFFECTS OF GROUP PARTICIPATION

An important thing to be learned from the experiments on "social climates" is that a situation which provides opportunities for individuals to become involved in what is going on — to participate in decisions as well as actions — has decided advantages over one which produces either apathy or aggressiveness. Two practical examples can be cited. The first



**16.12 Reactions to Three Kinds of Leadership.** Those subjected to autocratic leadership responded aggressively or apathetically, with resulting differences in specific reactions. Reactions to democratic leadership are also shown. (Derived from R. K. White in Maccoby, E. F., T. M. Newcomb, and E. L. Hartley (Eds.), *Readings in Social Psychology*, 3rd Ed. Holt, 1958, p. 501.)

has to do with the relative effectiveness of a lecture and a group discussion and the other shows how group participation in decision making may influence industrial output.

#### Lecture versus group discussion

During the last world war choice cuts of

meat were scarce, hence it was decided to see whether housewives could be induced to make greater use of less preferred animal organs, like beef hearts, kidneys, and sweetbreads. Accordingly, the following pilot study was undertaken by Lewin and his associates for the Food Habits Committee of the National Research Council.<sup>61</sup>

Three Red Cross groups were given a 45-minute lecture on the need to aid the war effort by using such products, their nutritional value, how to overcome the odors associated with cooking them, how to make them palatable, and so on. Recipes were distributed and the lecturer told how she prepared these "delicious dishes" and how well they were received by her family. This was the lecture approach.

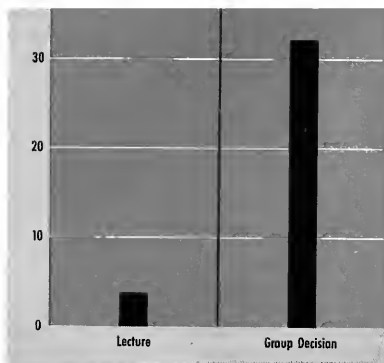
Three comparable groups were subjected to the "group-decision" approach. After some details were given, such as the need to utilize such food and its nutritional value, a discussion designed to produce group participation was started. The women were induced to discuss the problems which "housewives like yourself" might experience in using such food and how they might overcome these. During this session the various remedies and recipes given in the lectures were introduced, but only as the discussion turned in these directions.

Early in each meeting the women who had previously used the meats indicated this by raising a hand. At the end, all who would be willing to try them during the next week indicated this by a show of hands.

The investigators checked later to see which of the women who had not previously used these meats did so during the week following the lecture or discussion. The outcome is illustrated in Figure 16.13.

A similar advantage of group decision as against lectures has been found in the case of other products—for example, increased use of powdered milk. Group decision has also been more advantageous than individual instruction\* in persuading mothers to give their

\* This does not mean that class discussion should replace lectures in a classroom, even if this were practicable. What we are concerned with here is the relative effectiveness of lecture and discussion in inducing people to make decisions and follow them with appropriate action.



**16.13 The Relative Effectiveness of Lecture Versus Discussion.** Of those who had never before served the foods involved in this experiment, about 3 per cent served them after hearing a lecture and about 32 per cent after group discussion. (From Lewin, K., 61.)

infants cod liver oil and orange juice.<sup>62</sup>

Lewin attributes the superiority of group decision to several factors. The most important of these is no doubt the individual involvement which group discussion brings, as compared with the relative passivity which characterizes lectures and individual instruction.

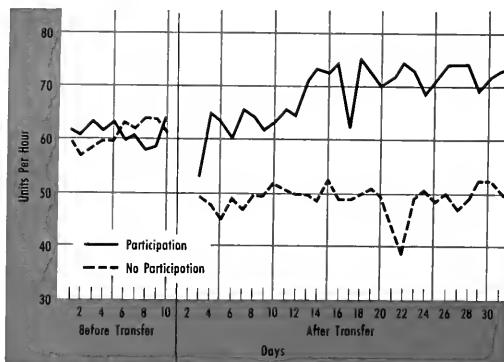
#### An example from industry

The problem investigated was how to over-

come decreased production which followed a change in work procedures. Women workers in a pajama factory were paid in terms of work units, with the standard level of efficiency being 60 work units per hour. When it was necessary to transfer operators to new jobs, rated in a comparable fashion with their former ones, there was usually a drop in efficiency. This represented a decrease of 10 or more work units per hour. During the re-training period a bonus compensated for what would otherwise be a loss in pay. Nevertheless, the work rate usually failed to return to its former level. Many women became discouraged and either gave up trying to improve, or left the job. The investigators, interpreting this situation from the standpoint of group dynamics, regarded it as an outcome of resistance to change.<sup>63</sup> They felt that resistance might be reduced by procedures similar to those just described. Accordingly, women to be transferred were formed into separate groups, each of which was introduced to the changeover in different ways. Only two procedures (the least and the most effective) will be described. They involve, respectively, *no participation* in the decision to change (control group) and *total participation* in this decision.

Members of the nonparticipating group were subjected to the usual factory routine in which the change-over was introduced with a statement that it was necessary to meet competitive conditions and that a new piece rate was being set, a rate explained by the time-study man. The participation procedure was very different. Workers met in small groups. The need to reduce costs was dramatically illustrated by having the women ex-

**16.14 Effects of Participation and Nonparticipation in Decision Making.** Whereas both groups had comparable production records (60 units per hour) prior to transfer, the nonparticipation group decreased its efficiency and did not return to the former level while the participation group, after a brief decline, actually increased its efficiency. (After Coch, L., and J. R. P. French, 63, p. 522.)





amine two garments which, despite a large difference in cost of production, they could not distinguish. Under these conditions, many suggestions were made by the members and a plan of operation was approved by the group.

The different outcome of these approaches is graphically demonstrated in Figure 16.14. Note that the control group made little recovery after the change-over whereas the experimental group not only reached the former level of 60 units per hour, but exceeded this by a large margin. There was also general satisfaction with the job in the latter group, and no turnover during a subsequent period of observation.

Enough of this experiment and its outcome has been described to indicate that, here again, the group dynamics approach successfully supplanted the usual procedure.

#### GROUP PRESSURES ON INDIVIDUAL JUDGMENT

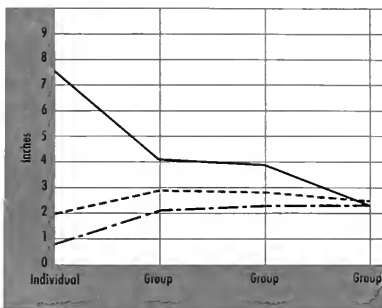
We are all subjected to group pressures — daily, in fact, from the time of birth and for as long as we live. Socialization, referred to so frequently in earlier discussions, is one example of this. In adult life we are also influenced, sometimes positively and sometimes negatively, by what others in our immediate vicinity are doing and saying. As a result, we may change our tastes, our attitudes, our opinions, and our judgments. The two experiments about to be described show how even a small temporary group may influence the perceptual judgments of one of its members.

##### The autokinetic experiment

The first experiment involves what has been called an *autokinetic effect*. If you were put into a completely dark room and a small fixed spot of light were exposed, you would see it move in different directions as though moved here and there by the experimenter. This illusory movement is the autokinetic effect.

A subject entered the dark room with the experimenter, who pointed to a response key and said:

When the room is completely dark, I shall



**16.15 Individual Conformity to Group Norms.** These are the averages for three individuals. In the initial series, where each reported the amount of movement individually, there was marked divergency. In a succession of tests with the three reporting in each other's presence, there was the illustrated funneling effect. Finally, all were giving similar reports. (From Sherif, M., 64, p. 33.)

give you a signal READY, and then show you a point of light. After a short time the light will start to move. As soon as you see it move, press the key. A few seconds later the light will disappear. Then tell me the distance it moved. Try to make your estimates as accurate as possible.<sup>64</sup>

Two seconds after a subject pressed the key, a shutter closed and the light disappeared. Then another trial was given. In all, 100 judgments were obtained from each subject. With isolated subjects working in this way the investigators established individual norms. Although there was no actual movement, each subject settled down, after a time, to judgments which, while they differed from those of other individuals, were more or less stable for him. Thus one subject reported an average movement of 7.5 inches, another of 2 inches, and still another of .5 inches, as indicated at the left of Figure 16.15.

To test for a group influence, the same subjects were subsequently placed in the dark-room together. Now they heard each other's reports, with the result illustrated in the

graph. One can see that, in three successive sessions, their judgments converged. Two were influenced to raise their estimates slightly. One lowered his until it conformed with that of the others. This happened in other groups, but not always with changes as marked as in the case of the latter subject.

Some subjects were tested in the group situation for three sessions, then alone. These carried the former judgment into the individual situations, as illustrated in Figure 16.16. The group influence, which became apparent early in the first session, led to a marked similarity of judgment and, as one might well expect, this carried over to the last session, where the individual gave his judgment in isolation.

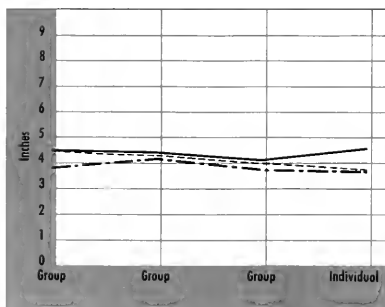
Later research<sup>65</sup> suggests that some of this group effect is due to the way a subject views (or structures) the situation. Although the movement is purely subjective, and there is therefore no positive answer to the question "How far did the light move?" one usually assumes that movement has actually occurred and that his judgment, as compared with the judgments of others, must be faulty. Therefore he tends to make a correction. This was confirmed in a repetition of the above experiment with college women. In some of the later experiments, however, the subjects were

told that movement was illusory and that nobody was necessarily more accurate than anybody else. Each subject was paired in the darkroom with another who was, so to speak, "fixed." The latter had been instructed to give reports within a certain narrow range regardless of what she actually experienced. Now the convergence of reports observed in earlier experiments did not so often appear. In a group of ten naive subjects tested in this way, only four showed the usual convergence, and these either forgot about the illusory nature of the movement or did not believe what they had been told concerning this.

### One against a majority

The second type of group-pressure experiment that we wish to consider differed in certain important respects from the one just described. First, it dealt with a real difference (Figure 16.17) rather than an illusory one, hence actual errors could be measured and their magnitude compared for the different conditions of the experiment. Second, as illustrated in Figure 16.18, it involved a larger group and a more natural situation than that of the first type of study. Finally, it placed the individual in a situation where there was a decided conflict between the evidence of his senses and what other members of the group were reporting. This was because (unknown to him) each of the others had been instructed to give the correct line on certain trials and, on all other trials, to respond unanimously by naming a certain incorrect line. The correct estimates were interpolated so as to mislead the subject. Estimates were given, in order, by individuals 1 to 7. Table 16.1 makes the situation very clear. There were 18 trials. On the first of these the standard line was 10 inches long. The comparison lines were (1) 8½ inches, (2) 10 inches, and (3) 8 inches. The correct line was obviously No. 2, and the group, beginning with the first member and proceeding in succession to the subject, and one beyond him, all gave this as their estimate. On the next trial, the line was 2 inches long. Now, in order, the comparison lines were 2, 1, and 1½ inches. Again there was unanimity, all in this case designating No. 1. On the third trial,

**16.16 Effect of Earlier Group Experience on Individual Judgments.** This figure is to be compared with the preceding one. It shows absence of the funneling effect often found when individuals are first tested alone. (From Sherif, M., 64, p. 33.)



however, the other members of the group unanimously gave a response that was incorrect. The line was 3 inches long; the three other lines were, in order,  $3\frac{3}{4}$ ,  $4\frac{1}{4}$ , and 3 inches long. The correct line was No. 3, but

everyone except the naive subject said that it was No. 1. The error was thus  $\frac{3}{4}$  inch. On the next trial the group again differed from the naive subject. On the next they agreed with him. And so on, as shown in the table.

Table 16.1 Lengths of Standard and Comparison Lines

Trial	Length of standard line (in inches)	Comparison lines (in inches)			Correct response	Group response	Majority error (in inches)
		1	2	3			
1	10	$8\frac{3}{4}$	10	8	2	2	—
2	2	2	1	$1\frac{1}{2}$	1	1	—
3	3	$3\frac{3}{4}$	$4\frac{1}{4}$	3	3	1*	+ $\frac{3}{4}$
4	5	5	4	$6\frac{1}{2}$	1	2*	- 1.0
5	4	3	5	4	3	3	—
6	3	$3\frac{3}{4}$	$4\frac{1}{4}$	3	3	2*	+ $1\frac{1}{4}$
7	8	$6\frac{1}{4}$	8	$6\frac{3}{4}$	2	3*	- $1\frac{1}{4}$
8	5	5	4	$6\frac{1}{2}$	1	3*	+ $1\frac{1}{2}$
9	8	$6\frac{1}{4}$	8	$6\frac{3}{4}$	2	1*	- $1\frac{3}{4}$
10	10	$8\frac{3}{4}$	10	8	2	2	—
11	2	2	1	$1\frac{1}{2}$	1	1	—
12	3	$3\frac{3}{4}$	$4\frac{1}{4}$	3	3	1*	+ $\frac{3}{4}$
13	5	5	4	$6\frac{1}{2}$	1	2*	- 1.0
14	4	3	5	4	3	3	—
15	3	$3\frac{3}{4}$	$4\frac{1}{4}$	3	3	2*	+ $1\frac{1}{4}$
16	8	$6\frac{1}{4}$	8	$6\frac{3}{4}$	2	3*	- $1\frac{1}{4}$
17	5	5	4	$6\frac{1}{2}$	1	3*	+ $1\frac{1}{2}$
18	8	$6\frac{1}{4}$	8	$6\frac{3}{4}$	2	1*	- $1\frac{3}{4}$

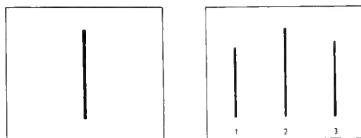
\* Starred figures designate the erroneous estimates by the majority. (From Asch, 66, p. 6.)

Some subjects found this a disturbing experience. To use the investigator's words: "one individual found himself suddenly contradicted by the entire group, and this contradiction was repeated again and again in the course of the experiment. . . . He faced, possibly for the first time in his life, a situation in which a group unanimously contradicted the evidence of his senses."<sup>66</sup> Very few subjects suspected the nature of the experiment. Data for those who did were discarded.

The investigator sought to discover how individuals in such a situation would react. Would they resist — sticking to what *they* perceived to be true — or would they yield to the majority? As the reader can perhaps anticipate, there were marked individual differences. In a group of 50 subjects, about 25 per cent reacted in complete independence

of what others said. The remainder showed varying degrees of change in the group-suggested direction. The subjects of a control group gave their judgment in writing and without a group influence. They averaged 0.8 errors. On the other hand, those subjected to group pressures, as described, averaged 3.84 errors. The range was from 0 to 11 errors out of a possible 12.

Even those subjects who had no errors were



**16.17 Sample Cards of the Judgment Experiment.** The first line was shown and covered. Then the individual was to say which of the lines on the second card equalled it in length. (From Asch, S. E., 66, p. 7.)



**16.18 The Group Pressure Situation.** As described in the text, all but a naïve student had been instructed to give unanimously incorrect judgments about the length of lines on cards as shown in Fig. 16.17. Reports started with man 1 and ended with man 7. The naïve subject (6) found his judgments to be in conflict with those of the group. (Courtesy *Scientific American*.)

at times disturbed. Some became “doubt ridden and experienced a powerful impulse not to appear different from the majority.”<sup>67</sup> [The reader might refer, in this connection to what was said earlier (p. 167) about the urge to conform.] After each subject had completed the experiment, he was told that he had been misled, and why.

Other experiments of this nature placed two naïve subjects in the group. Some included a member instructed to agree with the naïve subject. Under both of these conditions, as might be expected, the influence of the majority was greatly reduced. In research designed to discover the influence of the size of the majority lined up against a single person it was discovered that the average amount of yielding (average departure from accuracy) becomes greater as the majority increases from one to four, but then remains about the same as more persons are added to the group.<sup>68</sup>

#### “Brain-washing”

The experiments that we have described dealt with relatively simple attempts to apply group pressures. So-called “brain-washing” is an extreme effort in the same direction. As the Chinese Communists are reported to have practiced this during and after the Korean

War, it included the pitting of individual beliefs against what appeared to be overwhelming contrary evidence. Take, for example, the germ-warfare propaganda that was designed to turn prisoners against their own countrymen:

Of particular importance were the germ-warfare confessions extracted from a number of Air Force officers and enlisted men. The Chinese made a movie of one or two of the officers giving their testimony to the “international” commission which they had set up to investigate the problem and showed the movie in all the camps. Furthermore, one or two of the officers personally went from camp to camp and explained how United Nations forces had used these bombs; this made a powerful impression on many men who had, until then, dismissed the whole matter as a Chinese propaganda project. The great detail of the accounts, the sincerity of the officers, the fact that they were freely going from camp to camp and did not look as if they were then or had previously been under any duress made it difficult for some men to believe that the accounts could be anything but true.<sup>69</sup>

There was much more to this “brain-washing” procedure, including enforced group discus-

sions in which the leaders kept the focus on Communist ideas, or on ideas derogatory to the United States and the United Nations. Moreover, the individual prisoner was cut off from any sort of communication from outside which would lend support to beliefs already held. Under such pressures, some prisoners, including the above-mentioned officers who supported the germ-warfare story, became indoctrinated in the desired direction. There were social pressures of other kinds, like punishing the group in retaliation for individual misdeeds and rewarding a desired response while punishing others. This is not to mention such background factors as isolation from loved ones and a condition of semistarvation. We cannot discuss the whole issue of brain-washing, but it is cited as a form of group pressure applied in a real-life situation.

### THE STUDY OF RUMOR

Rumor may be defined as "an unverified report or account of an event that circulates chiefly by word of mouth."<sup>70</sup> The account may have an element of truth, but it is almost certainly inaccurate, especially if much detail is involved. The rumor that Professor X dropped dead in the classroom (if this actually happened) is a mere statement of fact and not as likely to suffer distortion as the rumor, for instance, that the faculty is contemplating a "clamp down" on fraternities. In the latter instance there are no student witnesses to what the faculty is considering, student interests are involved, various possibilities of action may enter the story, and it could well be a complete fabrication.\*

Rumors are especially evident in times of public crisis (war, famine, natural catastrophe) where human welfare is involved and where, quite often, reliable information is lacking. Take, for example what followed the bombing of Pearl Harbor.

The affair was important because of the potential danger it represented to all of us, and

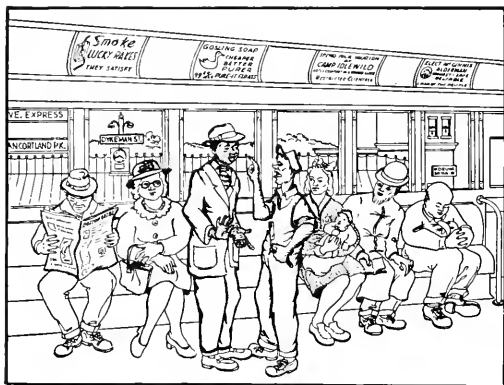
\* The reader not yet acquainted with Lady Gregory's one-act play, "The Spreading of the News," will get both enjoyment and some insight into the transmission of rumors from reading it.

because its aftermath of mobilization affected every life. It was ambiguous because no one seemed quite certain of the extent or reasons for, or consequences of the attack. Since the two conditions of rumor—importance and ambiguity—were at a maximum, we had an unprecedented flood of what became known as "Pearl Harbor rumors." It was said that our fleet was "wiped out," that Washington didn't dare to tell the extent of the damage, that Hawaii was in the hands of the Japanese. So widespread and so demoralizing were these tales that, on February 23, 1942, President Roosevelt broadcast a speech devoted entirely to denying the harmful rumors and to reiterating the official report on the losses.<sup>71</sup>

While it is possible to make field studies of rumor, the process itself can best be studied under the controlled conditions of a laboratory. The reader may recall that some studies described in earlier chapters are very relevant in this context. There were those dealing with memory for stories (pp. 316-318). A subject read the story and then told it to another, who told it to still another, and so on, until several had relayed it. We pointed out how the story became greatly abbreviated, with many details dropped, some details added, and other details distorted in various ways. This was not a study of rumor. It dealt with memory. But memory is important in the transmission of rumors. We also studied the inaccuracies which creep into testimony (pp. 318-319). Here our focus was on an individual who witnessed an event, then testified about it. This is comparable in some respects with the transmission of a rumor, for what the original observer tells another, in getting the rumor started, is subject to the same kinds of error that we described in the case of testimony. Moreover, what any person perceives of the story, as told to him, and what he passes on to the next person, is also subject to errors of testimony.

While these studies on memory and accuracy of testimony are relevant in the present context, and lead us to expect comparable inaccuracies in rumors, the latter have been subjected to specific investigation with small groups, usually of college students. Only one such study can be considered here.

The experiment took place before an au-



**16.19** A Picture Used in Experiments on Rumor. Typical reports are reproduced in the text. Only the person who started a "rumor" actually saw the picture. (From Allport, G. W., and L. Postman, 72, p. 71.)

dience from which six or seven volunteers had been selected to serve as subjects. These left the room and, after they did so, a picture was projected. One such picture is shown in Figure 16.19. It was visible to all in the audience, but not to each subject as he returned to the room, since a partition blocked his view. When the first subject entered, a member of the audience previously selected for this purpose, described what was on the screen. He had been asked to describe twenty details of the picture. After this, the next subject was admitted. He stood beside the first, who described from hearsay what was on the screen. After this, the first subject took a seat in the audience while the second subject told the third about the picture. This procedure continued until all had been told, and had been given an opportunity to tell about the pictured event. A record was kept of everything said.

The observer's description was usually quite detailed and it had a high degree of accuracy. But the story became less detailed and increasingly inaccurate as it went from one subject to another. Take, for example, the report of this subject, who was first to hear the story:

This scene is on a streetcar or a train. There are seven adults and one child. There is a woman sitting in one seat holding a baby and there is an elderly chubby man sleeping. Two of the adults are a colored man in a zoot suit and a white man having an argu-

ment. The white man has a razor in his hand. There are four ads, one is for "Lucky Strikes," one is for some soap, one for some sort of hotel.<sup>72</sup>

This report is less than half as long as the original and it includes several inaccuracies, which the reader may check for himself. The subsequent reports become progressively less detailed and increasingly erroneous. Take, for example, the fifth and sixth reports from the particular session we are describing.

This is a trolley car with seven persons on it. There is a woman with a baby. Somebody is flashing a razor. There are some signs and some colored people.

Picture of a trolley car with seven people. There is a woman with a baby. There are some colored people. Someone is flashing a razor blade.<sup>73</sup>

Two processes are quite evident in these experimental studies and in detailed rumors of every kind. The first process has been called *leveling*. This is the reduction of details. The other process is known as *sharpening*. It is evident when, as certain details drop out (leveling), others are increasingly emphasized, or made more pointed. Emphasis upon the razor, which is finally "flashing," is an example. There is also a sharpening of the color angle, even to the extent that there are "some colored people" instead of one. It

was not unusual for subjects to tie together the razor and the colored aspect, by having the colored man threaten the white man with the razor.

The latter illustrates another feature of rumors, the process of *assimilation* — “the powerful attractive force exerted upon rumor by the intellectual and emotional context existing in the listener’s mind.”<sup>74</sup> How does the report of a colored man threatening with a razor illustrate assimilation? For one thing, it is a prejudiced view of Negroes that they carry razors. By the same token, one does not expect to see a white man in a street car with a razor in his hand. Another prejudiced view is that Negroes are hot-headed. Thus a prejudiced person hearing the story in question may fit it into the framework of his prejudices, making it more understandable, more plausible, or more consistent with what he already knows, or thinks he knows, about the persons or situations with which a rumor deals.

Assimilation is also very evident in the transmission of humorous stories. One forgets most of the jokes he hears, but those which “ring a bell” in terms of his interests — sexual, medical, legal — are likely to be retained, and repeated whenever he has a listener.

There is a close affinity between the origin and transmission of rumors and the origin and transmission of legends. The latter are generally assumed to have had a basis in fact, but there is no doubt that the original details have been greatly reduced (leveled), that certain details have been greatly emphasized (sharpened) and that the legends in question (including particular details) have persisted because of the support that they give to values which the group wishes to perpetuate. Any story not so assimilated could not long persist.

#### BROADER ASPECTS OF COLLECTIVE BEHAVIOR

We have confined our discussion, in the main, to research on small groups, and to experimental research at that. But how about social behavior in the large? Nothing very specific has been said about the behavior of crowds and the development of social movements. To discuss these broader aspects of social life in detail would require at least another chapter and take us too deeply into

sociology and social psychology. What follows, therefore, is only a brief introduction for those who may wish to pursue these topics on their own initiative.

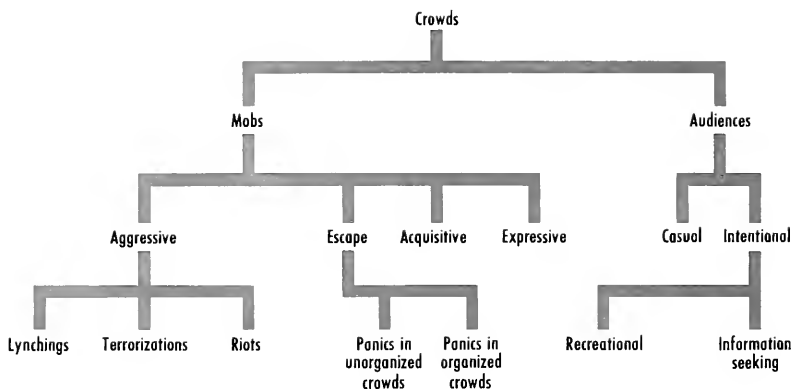
#### Crowd behavior

The term “crowd” needs some clarification, for, as Figure 16.20 indicates, it covers groups of various kinds. However, all have in common the fact that there is a temporary aggregation, with the individuals who compose it focused in a particular direction. In a mob, behavior may be directed toward destroying a building, lynching a person, or escaping from the scene of a disaster, but in an audience attention is focused on a speaker or a performer and there is little or no action from the group. What we shall be chiefly concerned with in the following discussion is mob behavior.

Historically there have been two widely different interpretations. One has emphasized the group itself, as though this were independent of the individuals who compose it. The other interpretation has emphasized the behavior of the individual who finds himself in a crowd.

The first of these interpretations is particularly associated with the name of Gustave Le Bon. In his book, *The Crowd*, Le Bon speaks of the crowd as having a “group mind” which supersedes the minds of the individual participants.<sup>75</sup> For illustrative material he draws largely upon aggressive mobs of the French Revolution. He notes that the individual in such a crowd is “swept up” so that he loses his individuality. The crowd is viewed as irrational and uncivilized. A participant, no matter how rational he might be as an individual, and no matter how civilized, is reduced to a bestial level of action. Le Bon said, in fact, that this person “descends several rungs in the ladder of civilization.” Other proponents of a “collective mind” have dealt with organized groups like political parties and nations rather than crowds.<sup>76</sup> Those who today speak of the “Russian mind,” the “French mind,” and the “Southern mind” are either speaking in a purely figurative manner or under the influence of group mind concepts.

The opposing concept stresses the behavior of individuals (acting as individuals)



**16.20 A Classification of Crowds.** This classification is given, not with the idea that anybody should memorize it, but only to indicate the broad meaning of the word "crowd" as used by sociologists and social psychologists. Roger W. Brown uses this as the organization of his chapter on "Mass Phenomena" in Lindzey's *Handbook of Social Psychology*. We have omitted two varieties of crowds which Brown gives as subdivisions of lynching mobs. (From Gardner Lindzey, *Handbook of Social Psychology*, 1954, Addison-Wesley, Reading, Mass.)

but with recognition of the fact that an individual's behavior changes in certain respects when he finds himself in the presence of other people. One influential advocate of this viewpoint is Floyd H. Allport, whose *Social Psychology* did much to further its wide acceptance.<sup>77</sup> Allport asked such questions as "What happens to the group mind when the individuals go their separate ways?" He pointed out that the person in a crowd acts as an *individual*, and that he may react even *more so*; by which he meant that there is a permissiveness about a crowd situation that may induce the individual to react in a less inhibited way than when he is in other situations. The individual would normally not *think* of looting a store, let alone do it. But when others are looting he may join them. The idea that "everybody's doing it" and the feeling that *he* cannot be singled out and punished for his acts are in part responsible for this change. A similar interpretation may be placed on lynching.

A great deal has been written about the

heightened suggestibility of individuals in crowd situations. It is not uncommon to find writers speaking, in this connection, of "mass hypnosis" and "mass hysteria."<sup>78</sup> The reader may recall from an earlier discussion (p. 16) that hypnosis, an extreme form of suggestibility, has at times been linked with hysteria. Some have used the concept of social facilitation (p. 461) to account for certain features of crowd behavior. Many writers have stressed man's imitativeness (p. 156) which, as we said in an earlier discussion, is a common social habit (coenotrope) acquired early in life.<sup>79</sup> Imitation is often invoked to account for uniformities of behavior in panics. The individual, seeing others run, may unthinkingly copy their behavior. Another interpretation of the same phenomenon is that every individual, being similarly motivated to escape, does what others are doing without necessarily imitating the others.<sup>80</sup> In any event, the behavior is that of individuals (as Allport maintains) and there is no need for the concept of a collective mind.



Some crowds are led and others leaderless. The emergence of a leader is of considerable importance, for he focuses attention and brings unanimity to what might, without him, be unconcerted action. He often sets the goal and the ways to accomplish it. His influence may, of course, be either constructive or destructive.

### Social movements

It has been said that a social movement is people "going somewhere."<sup>81</sup> As the term is customarily used, it refers to large masses who are more or less rapidly changing their way of life, or some aspect of it. Another designation is "mass movement." Such movements may be economic, political, or religious. Sometimes they are all of these combined. Take, for example, the abolitionist movement which preceded the Civil War.

A social movement may involve a relatively small segment of the population (like the religious movement known as "The Kingdom of Father Divine")<sup>82</sup> or it may involve many or even most members of an entire nation, like the Nazi movement in Germany.

Nazism will serve as an illustration of how a social movement develops and how dependent it is upon leadership.

All social movements begin with dissatisfaction. The group involved feels that "the times are out of joint." Germany, for example, had been beaten in war. There was economic chaos. Moreover, the Versailles Treaty "aroused unequivocal and furious resentment among the people. It was a final insult to the hard-won German nationalism." Germans expressed such sentiments as: "We prefer to sacrifice everything and fight to the last man rather than accept as cowards a peace that is against our honor."<sup>83</sup> For these reasons, and others that need not concern us in this discussion, there was widespread insecurity, unrest, and hopeless frustration. There was a felt need for leadership. It was here that Hitler entered.

The Nazi movement began in a small way. As Cantril puts it in his *The Psychology of Social Movements*,<sup>84</sup>

In 1919, a handful of disgruntled men were holding weekly meetings in a run-down Munich beer hall. They discussed the plight

of Germany, the remedies needed, the possibilities of Germany's rebirth. Like so many other groups of that period, they formed a political party. By 1933, this apparently insignificant band of beer-mug philosophers had been transformed into a mass movement that swept its leader into power.

Hitler emerged as the leader of this small group, and finally of the German nation, because his program and his personal characteristics, as revealed to the masses, held out some hope of resolving their individual frustrations.

What were the characteristics which gave Hitler leadership? And why did he, rather than someone else, assume this role? It was because

he was astute enough to guess what would be an appealing program, because he so clearly saw the weaknesses of his enemies, and because he possessed the capacity, the energy, the oratorical ability, the cunning, and the apparent sincerity to convince others and to organize among his followers a political instrument of enormous efficiency. He concentrated his attacks on enemies that were either weak or disorganized. Domestic enemies, such as the Jew or the Communist, were liquidated before opponents from industry or the army were taken on; small countries were swallowed up before the bout with England and France was risked. . . .<sup>85</sup>

To frustrated and disillusioned people, the picture of Germany as a nation of supermen must have been especially appealing. Their membership in the so-called "Nordic race," and their symbols and slogans welded them into a closely knit ingroup. Consolidation was fostered by giving them outgroups to hate—Jews and the Marxists. Frustrated people tend to look for scapegoats, and here they were. After Hitler gained sufficient power, he controlled the mass media of communication—press and radio. Thus his program could be promulgated in the broadest possible way and without opposition.

Hitler's role as *Der Führer* was enhanced by his "almost hypnotic" influence over the crowds which heard him speak. As the following statement by a psychological observer of his speeches points out, this was a two-way

process.<sup>86</sup> Hitler not only got a response, but he was quick to capitalize on this feedback.

His audience at a mass meeting was carefully selected: tickets of admission were obtainable at local Party headquarters and were generally given only to those who had already demonstrated sympathy for Nazism. These were the people, therefore, who possessed the predispositions that were likely to make them respond enthusiastically to Hitler's words. The audience generally awaited Hitler's arrival for many hours, and in the interim they listened to dull speeches by Party hacks. As a result, Hitler's opening words released temporary tension that had been gradually mounting within them. At the outset his voice was scarcely audible through the hall; people had to strain to grasp his sentences and to become accustomed to his Austrian accent. He himself looked subdued and weary. Suddenly a phrase or an idea would evoke some applause that was not necessarily engineered by a *claque*. Hitler then seemed stimulated by his listeners. He would begin to grow excited and would repeat the same thought in almost identical fashion. If the audience ever grew a trifle restless, their "leader" would rather quickly abandon his theme and grope for one that would produce cheers for Nazi principles and practices and jeers for those of his enemies.

The personal qualifications and tactics that we have cited served to broaden Hitler's leadership. Finally his role changed from that of leader to dictator. Now the people had no choice.

This sketch of the Nazi movement and Hitler's rise to power serves to re-emphasize something that was said earlier (p. 471) about leadership—the situation and the characteristics of the leader are integrally related. Without the stage being set for a role such

as Hitler's, he might have been a complete nonentity. On the other hand the stage could have been set, there could have been a role to play, but someone with the necessary qualifications could have been missing. The fact that this type of leader led Germany to disaster is beside the point.

How did individual Germans become involved in the Nazi movement? They were the frustrated ones, each frustrated in his own spheres of interest. Hitler offered a way out. He specifically addressed himself to interest groups (professional, industrial, and so on), and he played upon their hopes and fears. But once the movement had assumed immense proportions and the individual not only saw Nazis all around him but had Nazi principles and promises drummed in his ears via radio, and placed before his eyes in print and on the screen, he found himself in the midst of great social pressures. Members of his own family—via the Nazi Youth Movement—were also part of this. We saw in an earlier discussion (p. 480) that an individual against a unanimous majority, in even a small temporary group, may have his judgments subverted by this pressure. Our discussion of "brain-washing" (p. 480) is also relevant to what we are saying. It should be remembered, also, that some highly respected and influential non-Germans were persuaded by Hitler's acts and words that Nazism was the "wave of the future." Finally, of course, the individual German could not openly resist, unless he wished to lose everything he had, and possibly also his life.

This is but one social movement. Every movement has its unique setting and a leadership attuned to the peculiarities of the situation. A religious movement, for example, may have in common with Nazism only the fact that it begins with a desire for change and involves leadership attuned to the desires of those who are dissatisfied.

## Summary

Social behavior implies interaction of two or more individuals. Sometimes it is one-way, with one organism being stimulated by the other, as in socialization and imprinting. The

latter, a relatively simple instance of one-way interaction, is evident in goslings and other birds, as when the recently hatched bird follows its mother, or a mother substitute. There

is a critical period during which this learning occurs. In goslings it occurs during the first day. Once formed, response is persistent and irreversible.

Most of the behavior dealt with in this chapter involves reciprocal (two-way) interactions. One organism stimulates another and is stimulated (in turn) by the resulting behavior. In other words, there is a social feedback. We see elementary examples in the dominance relations of animals, in social facilitation, and in competitive and cooperative behavior. Our discussions of comparative social behavior demonstrated some resemblances between animals and human beings and suggested that caution is necessary in interpreting our social life as comparable with, for example, the dominance hierarchy of barnyard hens.

Status in human societies refers to the individual's relative position in the group structure. Familiar status designations are: upper class, middle class, and lower class. Socio-economic status is represented by such terms as "professional," and "unskilled." Status designations are always relative to the social setting. Role and status are closely related, since the individual of a certain status is expected to behave in ways which are more or less specified by his position. The status of "father," for example, brings with it certain obligations and responsibilities in the family situation. Each of us plays many roles in his daily life. These are learned, from infancy on, as we take our place in various groups.

One important approach in the study of small groups is "social field analysis" or what is known, in broader terms, as "group dynamics." It stresses such concepts as *life space*, *social field*, *intragroup tensions*, *resistance* to change, and so on. An individual's life space is, in general, his perception of his world, himself, and others. The social field represents other persons, whether actually or symbolically present. The term "locomotion" is used in its usual sense and in a special sense — as a shift in attitude, or making a decision. Overall emphasis is on the "subjective" world — the world as perceived by the individual in terms of his own interests and problems — rather than the objective world as viewed in terms of physical science. The husband-wife interaction discussed in this chapter exemplifies the "group dynamics" approach to interpersonal relations

as well as other aspects of group behavior. Other examples dealt with "social climates" and participation in decision-making.

Sociometric procedures deal with interpersonal relations, but without probing as deeply as social field analysis. There are several different sociometric techniques. They all require members of a group to nominate, or rate, other members for certain preferred positions. Persons are asked, for instance, to indicate whom they would "most like" or "least like" to serve as "roommate." Those selected by none are "isolates" and those selected by all are "stars." A refinement of the usual procedures utilizes the normal curve concept and requires individuals to nominate their peers in terms of specific needs, such as for loyal friendship. This method has been used, in fraternity situations, to obtain information on, for example, morale and leadership.

Studies of interaction in process involved small problem-solving groups and a twelve-item classification of acts which individuals were observed to make, acts like asking for information, giving an opinion, and showing tension. The item "gives opinion" was most frequently observed and comprised about 30 per cent of the total number of acts. In discussing this type of study we emphasized leadership and, in doing so, pointed out that this depends upon both the situation and the personal characteristics of the individual who leads — a point reiterated in the later discussion of social movements and their leaders.

Collective problem solving depends for its effectiveness upon the nature of the problem, the constitution of the group, and the information available to individuals. Where the information is parceled out to different individuals, collective problem solving is the only kind. However, its efficiency depends upon the nature of the "communication network." In our illustration, a wheel network was most and a circular network least effective. "Brainstorming" was given footnote mention. It appears of doubtful value unless preceded by special training.

Different kinds of leadership imposed upon groups is conducive to the creation of corresponding social climates. In most respects, democratic leadership is superior to other types. Laissez-faire is least effective. When subjected to autocratic leadership, some individuals react aggressively and others with apathy. Their

reactions to the leader differ accordingly.

Group decision-making is more effective than lectures and the imposition of changes, as in the food-acceptance study and that concerned with changing to new work methods in a factory.

Experiments on group pressures have involved judging the extent of illusory movement (autokinetic effect) and reporting on the actual length of lines. Both experiments demonstrated group-instigated changes in judgment. The latter experiment pitted one naive individual against a majority that was instructed to give false reports. About 25 per cent of the naive subjects completely resisted such pressure, although some were disturbed by it. The others conformed to varying degrees. Brainwashing is an example of extreme group pressure.

Rumors, unverified stories transmitted verbally, are prevalent during crises, and particularly when facts are unavailable or ambiguous. An experimental investigation of rumor was described and the concepts of leveling, sharpening and assimilation were discussed. *Leveling* is the reduction in details as a story passes along. *Sharpening* refers to the pointing-up of certain details, their relative importance in the story as other details drop out. By

*assimilation* is meant the reception given the story, in terms of prevailing beliefs, prejudices, and so on. This predisposition to accept, or reject, or modify the story is an important determining factor in the leveling and sharpening process.

There are various kinds of crowds, including sub-classifications of mobs and audiences. The concept of a "crowd mind" has particular relevance to mob behavior, where individuals often act in a manner different from what is customary when they are alone, or in other situations. Opposed to the crowd mind concept is that which conceives of the person in a crowd situation as an individual reacting to a particular type of social situation. He may be reacting even more individually than in the above situation because of his social conditioning and a realization of the fact that his behavior cannot so readily be singled out for criticism.

Social movements occur when people are dissatisfied with their way of life. As an example we described Nazism and Hitler's rise to power as its leader. Every social movement has its special background and leadership comes from individuals whose personal characteristics are consonant with the situation that exists.

(References and notes for this chapter are on page 569 of the Appendix.)

## Selected Readings

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## APPENDIX

<i>Answers and Solutions •</i>	490
<i>Glossary •</i>	493
<i>Statistics •</i>	537
<i>References •</i>	543

## Answers and Solutions

FIGURE 3.2, page 54:

Neurology, (1)

FIGURE 4.5, page 91:

Correct sequence of pictures is:  
D, F, C, A, E, B

FIGURE 4.7, page 93:

Correct answers are:  
C, E, E, B, D, A, A, D, A, E

PAGE 118: Vulnerability, D.

FIGURE 5.13, page 133:

The picture at the right is better.

FIGURE 7.1, page 176:

Left column — sorrow, surprise, grief.

Right column — delight, horror.

The situations were: her team lost, surprise party, members of family drowned, conversing with a senator, encounter with masked figure while crossing a field.

FIGURE 7.3, page 180:

The order should be from unpleasant to pleasant: A, F, C, G, H, E, B, I, D



A



F



C



G



H



E



B



I



D

FIGURE 11.5, *Photographs for recognition test*

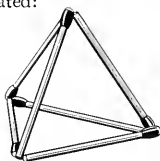
Indicate by number which twelve of the above faces appeared on page 322. Then turn back to that page and check your accuracy.

*Photographs used through courtesy of the Brunswick, Maine,  
High School and Pierce Studio*



FIGURE 12.6, page 345:

- A. The six matches should be arranged as here illustrated:



- B. The area of the square is 16 units.  
C. The tumor is treated by rays coming from different directions but coming to a focus at the tumor.

FIGURE 12.7, page 347:

Begin at the top:

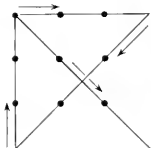


FIGURE 14.1, page 394:

The darkened area shows the location of the motorcycle policeman.



FIGURE 14.5, page 406:

Top row, left to right: trilobite, transistor, sand dollar;  
bottom row, left to right: scarab, spark plug, coral.

FIGURE 14.6, page 407:

Man on horse, man taking picture with graflex camera.

FIGURE 14.7, page 408:



FIGURE 14.13, page 416:

An exterior view of a distorted room similar to that shown on p. 416, showing how it is constructed to create the deceptive illusion.

(Photographed for Life by Eric Schaal.  
© Time, Inc.)



FIGURE 15.13, page 452:

From left to right, the signals mean: OK, stop, squelch him, give me a ride.



## Glossary

*Our glossary defines all technical terms used in this textbook, but the meanings given are only those relevant to the present subject matter. Many terms have additional meanings, relevant to other contexts. For these, and for definitions of additional psychological terms which the student may encounter in his outside reading, the following dictionary will prove especially helpful: English, H. B., and A. C. English, A Comprehensive Dictionary of Psychological and Psychoanalytical Terms, Longmans, Green, 1958.*

- ability** Present skill, as in riding a bicycle or reciting a poem. Contrasted with *capacity* in that it refers to what an individual *does* do rather than what he might do if given appropriate training.
- abnormal** *Ab* (away from), hence diverging from the normal.
- abscissa** The horizontal (or *x*) axis of a graph.
- abstracting** Discerning the common elements in situations which are otherwise different.
- abstract thinking** Thinking in terms of concepts and general principles, as contrasted with thinking of specific things.
- accommodation** Changes in the lens mechanism of the eye which focus it for different distances.
- achievement motive** Ego involvement such that the person desires to make a good impression on others by positive accomplishment.
- achievement test** A test which, as distinguished from aptitude and intelligence tests, measures what has been accomplished in specific areas, as in mathematics, history, or French.
- achromatic** A (without) *chroma* (color), hence without hue as in a black and white picture.
- ACTH** (Adrenocorticotrophic hormone) The hormone from the anterior pituitary which stimulates the adrenal cortex.
- acquired** Developed or learned during an individual's lifetime.
- action current** An electrical disturbance which traverses the nerve fiber after stimulation. Also electrical voltage shift accompanying other activity of living cells.
- activity cage** One with a device to record the running or other activity of an organism placed within.
- activity cycle** Rhythmic fluctuations of activity, as in the two-hour hunger and four-day sex rhythms of rats.
- adaptation** Adjustment. Sensory adaptation involves a change in the characteristics of experience as a result of prior stimulation, as when we gradually see more clearly in a darkened room or taste something as especially sour after eating sweets.
- adjusted learning** The situation is arranged so that fast and slow learners acquire equal amounts and without the chance to overlearn.
- adjustment** Accommodating or fitting oneself to circumstances, as when we say that an animal is adjusted to its environment or that a student is adjusted to, or gets along well with, the group in which he finds himself.
- adrenal gland** An endocrine gland, about the size of a pea, located above each kidney. The central part (medulla) secretes adrenin (adrenalin), and nor-adrenalin, while the outer part (cortex) secretes cortisone.
- adrenalin (adrenin)** A secretion of the adrenal medulla. Also see *nor-adrenalin*.
- aerial perspective** Clearness of details under different atmospheric conditions. Objects with clear details appear nearer.
- aesthetic preference** A preference based upon feeling, as in the case of pleasantness or unpleasantness commonly used in judgments concerning art.
- affective process** One which underlies or involves feeling or emotion.
- afferent** Sensory (leading in).
- aggression** Hostility which may involve actual attack or pushing around of other people.

- alarm reaction** Referred to by Selye, in his concept of stress, as a "generalized call to arms of defensive forces in the organism."
- alcoholic psychosis** Mental illness brought on by use of alcohol.
- alerting mechanism** One which makes the organism attentive to things and events.
- all-or-nothing principle** A nerve fiber, or muscle fiber, if it responds at all, responds completely.
- ambivalence** Being pulled in opposite directions, as in both loving and hating the same person.
- ambivert** One who has neither pronounced introvert nor extravert characteristics; a person between these extremes.
- amnesia** Loss of memory, as after a blow on the head or an emotional upset.
- amplitude** The extent to which a vibrating body is displaced from the resting position.
- ampullae** The enlargements at the base of the semicircular canals.
- anaglyphs** Pictures in two colors which, when viewed binocularly with suitable filters, give a tridimensional effect.
- androgens** The male sex hormones (testosterone).
- anecdotal method** The collection of stories about the doings of animals and babies.
- anesthesia** Partial or total loss of sensitivity, especially used in relation to skin sensitivity, as when one's sense of pain is dull or absent.
- animal hypnosis** See *tonic immobility*.
- animal magnetism** What Mesmer believed hypnosis to be.
- animism** Attributing life to inanimate things.
- anterograde amnesia** Forgetting of what took place during or after a disturbing event, presumably because what was happening made no impression. See *amnesia* and compare with *retrograde amnesia*.
- anthropomorphism** The attributing of human traits to animals.
- anticipation method.** In memory experiments, one item is given and the subject attempts to recall the next, and so on, until the whole list can be recalled without prompting.
- anticipatory response** One in terms of a present stimulus which signals a stimulus to come, an expectant response.
- anvil** Small bone in the middle ear located between the hammer and the stirrup.
- anxiety** Apprehension, dread, uneasiness. The emotion stems from fear, but it is more a fear of what might happen, or what has happened, than of a clearly apparent fear-provoking situation. An important term in psychiatry with shades of meaning which differ depending upon the school of psychoanalysis followed.
- anxiety neurosis** Mental illness characterized by anxiety with insufficient cause.
- aperiodic** Without a rhythm, or cycle.
- aphasia** Literally, without speech. A disorder involving loss of linguistic meaning, such as loss of the ability to understand what is heard or what is read. Motor aphasia is loss of the ability to articulate.
- apparent motion** See *phi-phenomenon*.
- appetite** Readiness to eat, but sometimes also used with reference to sex, as in so-called sexual appetite.
- aptitude** The capacity to learn readily and achieve a high level of skill in some specific area, such as music, mathematics, or mechanics. Contrasted with *ability* in that it refers to potential rather than actual accomplishment.
- aqueous humor** Watery substance behind the cornea of the eye.
- Army General Classification Test (A.G.C.T.).** Used to measure intelligence and aptitude for various aspects of military service.
- aspiration** Striving to reach a certain level of performance, hence the term *level of aspiration*.
- ascending paths** Those rising to the brain from lower levels of the nervous system.
- assertiveness** The tendency to master, to "push" or to be aggressive.
- assessment** Evaluating an individual with respect to his various traits. See *holistic assessment*.
- assimilation** To absorb, or adapt to one's own needs or purposes. With reference to rumor, the reception and modification of a story in terms of the recipient's beliefs, prejudices, or values.
- association** The function of relating, bringing together, or connecting. *Association neurons* connect other parts of the nervous system; the *association experiment* is one in which the subject recalls items previ-

- ously connected with or related to the stimuli presented.
- associative strength** The strength of an S-R association as measured by the frequency with which a given stimulus elicits a particular response. Thus the stimulus word *white* more often brings the response *black* than the response *green* (is more likely to bring the response *black* than *green*). We can say, therefore, that the *white-black* terms are more strongly associated (or have greater associative strength) than the terms *white-green*.
- asthenic physique** Thin, slender, ectomorphic.
- ataxia** Muscular incoordination.
- athletic physique** Muscular, strong.
- attending** Getting ready to perceive, as in listening or looking, or defining the center of clearness in perception. Focusing of sense organs sometimes involved.
- attitude** A predisposition to react in a certain way, a readiness to react, a determining tendency.
- audiogenic seizure** A behavior disorder, resembling an epileptic attack, but produced by auditory stimulation, usually of a very high pitch.
- audiovisual** Involving both hearing and sight.
- audition** Hearing.
- auditory labyrinth** Part of inner ear concerned with hearing.
- auditory localization** Evidenced by ability to name or point to positions from which sounds emanate.
- authoritarian** An authoritarian is one who acts in a dictatorial fashion in his relations with others. We have used the word as an adjective, especially with respect to the role of a leader in social situations. Thus, the authoritarian leader is one who dictates what others must do, thus creating what Lewin has called an "authoritarian climate" within the group. This is in contrast to situations (climates) calling for group decision. See **democratic leadership**.
- autokinetic effect** The apparent drifting movement of a small fixed spot of light in a dark room.
- automation** The use of machines to replace men in the control of industrial and other operations. See **electronic brain**.
- autonomic nervous system** The relatively independent system, comprising the sympathetic and parasympathetic systems, which regulates the various inner organs of the body, like the heart, stomach, and glands.
- aversion** A tendency to avoid, to dislike.
- avoidance training** Where the organism avoids punishment by making an appropriate anticipatory response. Compare **escape training**.
- axon** That part of the neuron which carries the nerve impulse away from the cell body and into the end-brush. The motor axon carries the nerve impulse into the muscle fiber; the sensory axon into synaptic connections with the dendrites of a motor or an association neuron.
- babbling** The repetitive vocalizations of a baby, as if in self-imitation.
- ballisto-cardiograph** There are different kinds of ballisto-cardiographs, but these have in common the fact that they record heart activity indirectly, through movements of the body (very delicately balanced on a stabilimeter-like table) that are produced by the propulsive force of the flow of blood. One such instrument was used to study emotional stress. Figure 7.8 reproduces some of the ballisto-cardiograph tracings obtained in this experiment. Compare **electro-cardiogram**.
- Bard-Cannon theory** Idea that the feeling aspect of emotion as well as the pattern of emotional behavior is controlled by the hypothalamus.
- barriers** The more or less insurmountable obstacles which interfere with need-satisfaction. They may be environmental (social or non-social) or within the individual. Barriers function psychologically only when the individual recognizes their existence.
- basal age** The Mental Age (M.A.) credited for passing all items of the Stanford-Binet Test at the level just prior to that at which some items are failed.
- basilar membrane** Membrane at the base of the cochlear canal which has an important function in hearing.
- behavior** Anything that an organism does or says.

- Behaviorism** School of psychology which stresses an objective natural science approach to psychological problems. Observations are confined to behavior. Conscious experience, because of its subjectivity, is considered outside the scope of a scientific psychology.
- behavior tests** Those which rate or otherwise measure observed reactions to actual life situations.
- belittling** A compensatory reaction in which the individual increases his own self-esteem by disparaging what others do, or have done.
- Berkeley Growth Study** A longitudinal study of mental growth carried on at the University of California in Berkeley.
- bimodal** Refers to a frequency distribution with two modes.
- binary digit** A digit utilizing the symbols 0 and/or 1. Used in information theory and in so-called digital computers, where, for example, 0 is zero, 1 is one, 10 is two, 11 is three, 100 four, 101 five, and so on.
- Binet-Simon scale** The forerunner of other individual intelligence tests like the Stanford-Binet. It was developed in France by Binet and Simon.
- binocular** Involving both eyes at the same time.
- biographical method** Tracing the development of behavior by recounting incidents which occurred at various age levels. Also referred to as the *life history* method.
- biological memory** Sheer retentivity underlying recall and other aspects of memory. See *engram*.
- biosocial** Involving the interplay of biological and social influences.
- bipolar cells** Cells with two poles as in the case of those in the retina which connect synaptically with both the rods (or cones) and the ganglion cells of the optic nerve.
- bit** A contraction of **binary digit**. It has a meaning peculiar to information theory, where it is used to represent an amount of information (not necessarily small) which reduces uncertainty (the alternatives relevant to a situation) by one half. Also see **binary digit** and **information theory**.
- blaming others** Excusing oneself for failure on the grounds that others are responsible.
- borderline intelligence** Between two classes, as between moron and average.
- brain** A term which embraces the large mass of nerve tissue above the spinal cord, including the brain-stem, cerebellum, and cerebral hemispheres.
- brain stem** The part of the brain which would remain if the cerebral hemispheres and cerebellum were removed. However, some
- brain-storming** A term coined to represent a group problem-solving situation where members of the group contribute any ideas which seem relevant to them. It is a special kind of situation, functioning under certain rules designed to foster creative ideas.
- brain-washing** Inducing people to modify their attitudes and behavior in certain directions through various forms of social pressure and perhaps, also, physical torture.
- brightness** The intensity aspect of light; the visual dimension represented by the black-white continuum. The term is also used to represent a high level of intelligence, in contrast with dullness.
- Broca's area** A region in the left motor area of the cerebral cortex which plays an important, if not crucial role, in the articulation of speech sounds. Named after Broca, who discovered it.
- caffeine** Fatigue-alleviating drug in tea, coffee and cola drinks.
- capacity** Similar to aptitude. It implies potential, as compared with actual, accomplishment. The individual's capacity to learn some skill, for example, might be inborn, it might depend upon prior learning, or it might, and probably would, depend upon a combination of these.
- cardinal number** One of the principal numbers, such as one, two, three, four, and so on.
- case history** Assembling of data which reconstructs an individual's past, the aim being to understand his problems and aid in his adjustment.
- catatonic** A form of schizophrenia (or a person with schizophrenia) characterized by such symptoms as extreme negativism and holding of bizarre postures.
- categorizing** Placing different items in a particular category (class) in terms of some

- common property or in accordance with some principle. See **concept formation**.
- cell body** The compact central portion of a neuron; that is, the neuron exclusive of its projections.
- central nervous adjustment** Adjustment involving the brain and spinal cord without necessary involvement of the receptors and effectors.
- central nervous system** The brain and spinal cord.
- central theory** Theory which stresses central nervous adjustment as defined above.
- cerebellum** Brain structure, connected to the brain stem via the pons, whose function is primarily that of motor coordination.
- cerebral cortex** The greatly invaginated outer layer of cerebral gray matter and the center for many complex neural adjustments.
- cerebral hemispheres** The two structures, joined at the corpus callosum, which together comprise the cerebrum.
- cerebrotonia** Temperament characterized by such features as restraint, shyness, hypersensitivity, and reflection.
- cerebrum** The cerebral hemispheres.
- character** Personality viewed from the standpoint of the ethical or the moral, as in the case of honesty; ordinarily has reference to relatively fixed traits.
- chlorpromazine** One of the more potent tranquilizing drugs.
- choroid coat** The middle, pigmented layer of the eyeball whose prime function is to exclude light.
- chromatic vision** Vision which involves hues, as in a technicolor picture.
- chromosomes** Structures within the nucleus of a cell which contain the hereditary determiners, or genes.
- chronic** Persisting over a long period.
- chronological age** Actual age from birth.
- chronoscope** A device with which speed of reaction is measured. A signal is given, the chronoscope starts, and the subject's reaction stops it.
- ciliary muscle** Muscle which regulates the curvature of the lens, hence focuses the eye for clear vision.
- circumvallate papillae** Structures toward the back of the tongue which contain receptors; generally credited with mediating bitter tastes.
- classical conditioning** As in the experiments of Pavlov and Bechterev where the unconditioned stimulus followed the conditioned stimulus whether or not the animal responded to the latter.
- clearness** An aspect of attending, in that what we attend to becomes clear, in focus. See **attending**.
- client-centered therapy** The client does most of the talking, makes his own diagnosis, and finds a solution with minimal guidance from the counselor. See **non-directive therapy**.
- clinical procedure** Having to do with the diagnosis and treatment of an individual case.
- clinical psychology** Concerned with diagnosis and psychotherapy of the milder behavior disorders, like speech defects, school difficulties, and neuroses. Many clinical psychologists work in collaboration with psychiatrists, especially where more serious behavior disorders, like the psychoses, are involved.
- cochlea** Coiled structure of the inner ear which contains the receptors essential for hearing.
- code** As used in this book, a system of symbols (like Morse code or Braille) for transmitting information. See **encoding** and **decoding**.
- coefficient of correlation** A statistic which represents the degree of relationship between two variables, or how closely variations in one series of measurements are concomitant with variations in another paired series.
- coenotrope** A common habit, one which most members of a group have acquired. Distinguished from many habits in that the latter tend to differ from one person to another and from instincts in that these are inborn rather than acquired.
- collective behavior** Group behavior, behavior of interacting individuals.
- color blindness** A weakness or defect in sensitivity to hue as in the case of red-green blindness where the individual has difficulty in distinguishing red and green from grays of the same brightness level.
- color vision** Response to the wave-length properties of light, i.e., what we experience as hue.
- color zones** Regions of the retina which are

- especially sensitive to particular wave lengths of the visible spectrum.
- common social motive** One widespread within a particular cultural group and which originates in social influences to which children are subjected. Distinguished from a motive which has its origin in the physiological makeup of the organism.
- communication** A form of interaction in which the behavior of one organism acts as a stimulus for the behavior of another. In verbal communication, a spoken (or written) word serves as the stimulus to arouse relevant symbolic processes in the hearer (or reader). It is often said, in this instance, that information has been transmitted from one person to the other.
- comparative psychology** Often used as synonymous with animal psychology. More strictly, the comparison of behavior at different levels of development in order to discover development trends—as in the evolution of intelligence from, say, ant to man.
- compensation** Counterbalancing some change (such as a lowering of temperature) or some defect (such as a feeling of inferiority). The term has somewhat different implications depending upon the different schools of psychoanalysis.
- compensatory movement** Movement such that a balance is reestablished, as when the speed of a car is regulated so that the speedometer does not go far above or below, say 50 miles per hour or when, losing his balance, the individual regains it. The first example is an instance of compensatory tracking. See *tracking*.
- complex** An emotionally toned group of ideas.
- complex coordinator** Apparatus used to select pilots which requires rapid, coordinated adjustments, to complex arrangements of stimuli.
- complex indicators** Indicators of a complex, like repeating the stimulus word, becoming confused, or taking a long time to react.
- complex learning processes** Those which call for use of symbolic processes, as in reasoning.
- compulsion** An irresistible urge to perform some act, such as stealing, lighting fires, or repeating a ritual.
- concept** Idea or conclusion based upon a generalization such as “anything burning is hot.”
- concept formation** Learning to respond in terms of concepts.
- conception** Fertilization of the ovum.
- conceptual** Pertaining to concepts, as in conceptual (or abstract) thinking.
- concrete thinking** Thinking in terms of particular things (like pears, apples, bananas) in contrast to thinking in terms of categories (like fruit). The latter is abstract (or conceptual) thinking.
- conditioned response** A response aroused by some stimulus other than that which naturally produces it, like salivation in response to a tone, or, as in operant conditioning, a response that has become more frequent under reinforcing conditions.
- conditioned stimulus** One which, through presentation with another stimulus which naturally arouses a response, itself comes to arouse the response, or some aspect of it.
- conditioning** Sometimes used, as synonymous with learning. More specifically, the process through which conditioned responses are developed.
- cone** Receptor for color vision.
- configuration** See *Gestalt*.
- conflict** The tension or stress involved when satisfaction of needs is thwarted.
- congenital** Present from birth, but not necessarily inherited. Congenital syphilis, for example, is not inherited but contracted through contact with the mother. Congenital idiocy, on the other hand, is sometimes the result of an hereditary defect in the nervous system and sometimes the result of a defective prenatal environment.
- conscience** A self-attitude assumed by the individual when he fails to conform to the moral or ethical ways of his group, or when he is tempted to behave in other than the approved ways; the superego.
- conscious experience** Experience of which the individual is aware, as distinguished from *past experience* of which he may or may not be aware at the moment. Conscious experiences may be considered as those which the individual can verbalize, or describe, such as sensory experiences and feelings.
- consciousness** Awareness, the sum total of subjective experiences at any moment.

- consolidation** Bringing together, unifying, or interrelating different things.
- constancy phenomenon** The tendency for brightness, color, size, or shape to remain relatively constant despite marked changes in stimulation.
- constant factors** Those held constant in an experiment, as distinguished from the independent variable.
- construct** Basically an inference concerning things or processes underlying the observable. Motives, for example, are constructs. Many theoretical terms in science are constructs. The *id*, the *subconscious* regarded as a region of the mind, and *insight* are psychological constructs.
- context** The general setting in which an event occurs, the surroundings.
- contiguity** Being together in space (spatial contiguity) or time (temporal contiguity).
- contingent probability** Probability dependent upon some preceding event, as when use of a particular letter (or word) determines to a certain degree what will follow in a word (or sentence). Thus in English *q* is almost always followed by *u*.
- control group** One comparable with the experimental group in all respects except the condition under experimental investigation.
- controlled** Varied or held constant, according to certain specifications, by the investigator.
- conventionalized** In accordance with established rules, as in the case of grammar and etiquette.
- convergence** The turning inward of the eyes, as in fixating a nearby object.
- cornea** The transparent front portion of the eyeball.
- correlation** A relationship between variables such that changes in one are accompanied by changes in the other, either positively (as when weight tends to increase with height) or negatively (as when increasing weight tends to go with decreasing speed of locomotion).
- cortex** Bark, outer layer, as in respect to the cortex of the adrenal gland and the cerebral cortex.
- Corti, organ of** Structure above the basilar membrane of the inner ear which contains hair cells important in activating the auditory nerve.
- cortical** Having reference to the cortex.
- cortical localization** The attributing of a certain function to some particular region of the cerebral cortex, like hearing in the temporal lobe.
- cortical rhythm** See **brain waves**.
- Cortisone** One of the hormones secreted by the adrenal cortex.
- cotwin control** The use of identical twins to control the hereditary contribution to behavior. One twin is subjected to experimental conditions while the other is not.
- covert** See **implicit**.
- cranial nerves** Those emerging from the cranium (skull).
- creative thinking** Thinking with novel, in contrast with routine, outcomes.
- cretinism** An abnormality of structure and behavior which results from insufficient thyroid secretion during early growth.
- cristae** Small structures in the ampullae of the semicircular canals whose hairs are bent by rotary motion.
- criteria** Those standards against which tests are validated — like grades or sales records.
- critical cut-off score** The score an individual must achieve in order to be admitted to a certain job, a school, or a branch of the Armed Services. The minimum acceptable score.
- critical period** This has special reference to imprinting. It is the period of maximum imprintability or, as sometimes used, the period before and after which imprinting is difficult or impossible to obtain. See **imprinting**.
- critical ratio** The difference between two means divided by the standard error of the difference.
- cross-sectional method** A developmental method involving the comparison of groups of individuals at different age levels. Contrasted with the longitudinal method, where the same individual is observed as he grows older.
- crowd** A temporary group of people interacting with each other, and having some common focus of attention. An audience has many features of a crowd, but it is usually more passive. Many kinds of crowds are recognized, such as aggressive crowds, lynching crowds, acquisitive

crowds, and so on. The latter are often referred to more specifically as mobs bent on aggression, lynching or looting.

**cueing function** A stimulus is said to have such a function when it produces guidance concerning an appropriate response. We have used the term with respect to motivation, where a particular drive state (like hunger) makes an organism especially responsive to food and food-related stimuli, like the odor of milk. Here it could be said that both the internal drive stimuli and the external food-related stimuli have cueing functions.

**culture** Traits, implements, beliefs, and practices which characterize a particular group of people, as their ways characterized the Aztecs.

**curare** A drug which has a paralyzing effect on muscles.

**cutaneous** Pertaining to the skin.

**cycle** Rhythm: in auditory stimulation, one full double vibration, often recorded in number of such vibrations per second.

**dark adaptation** Increasing visual sensitivity which is a function of time in darkness, or in low illumination.

**daydreaming** Fantasy engaged in while awake.

**decode** To translate signals so that they convey a message. Thus dots and dashes are translated into words. It is sometimes said that the cerebral cortex "decodes" the nerve impulses which reach it in such a manner as to give them particular meanings (visual, auditory, and so on.)

**decrement** Decrease, diminution, decline.

**déjà vu** The feeling that a new situation is familiar — that one has been there before.

**delayed matching in terms of a sample** Technique whereby the subject is shown a sample object and is required, after a delay, to select it from an assortment of new objects.

**delayed reaction experiment** A stimulus is presented and removed before the organism is released. This stimulus may be a light in one of three doors, to the lighted one of which the organism has been trained to respond. After an interval the situation is

again presented, but without the differentiating stimulus; in our example, the light. If the organism now responds as it did formerly, by going to the door in which the light had appeared, and if it does this consistently in a series of tests with the light in different positions, we say that it has demonstrated ability to perform this delayed reaction. What bridges the gap must be something in the organism which represents the stimulus (say the light) during its absence. This is a *symbolic process*. See *symbolic process*.

**delusion** A false judgment or conclusion, as when a mentally ill person believes that people are putting ground glass in his food.

**dementia praecox** Name formerly given to schizophrenia. It means "youthful insanity."

**democratic leadership** That which uses group discussion as a basis for action. It is said to establish a *democratic group climate*.

**dendrite** Part of the neuron which carries the nerve impulse toward the cell body.

**dependent variable** The variable (some aspect of behavior or experience) which goes with (depends upon) changes in the independent variable. Example, speed of reaction as dependent upon the intensity of the stimulus to which the response is made.

**depression** A low point, such as low spirits. As applied in abnormal psychology — a melancholy mood, a feeling of hopelessness, an attitude of dejection. In serious cases, a symptom of grave mental illness.

**deprivation** A lack of something which the organism needs, as when a hungry animal is deprived of food, or a thirsty one of water.

**depth perception** Perceiving depth (tridimensionality) or distance.

**depth psychology** That which probes into the motivational or so-called *dynamic* aspects of personality, especially those of which an individual is not aware or, in Freudian terminology, of which he is *unconscious*.

**descending paths** Tracts beginning at upper levels of the nervous system and terminating at lower levels.

**determiners of attention** The various conditions which influence attentiveness — like the *size* of a stimulus or the *interest* of an indi-



- vidual in what is before him. The former would be an external and the latter an internal determiner.
- determining tendency** An attitude which predisposes the organism to react in a certain way.
- deterrent** Something which repels the individual, as contrasted with an incentive, which attracts him.
- detour problem** One in which the organism must approach the goal indirectly, by a roundabout way.
- development** Growth, as when an organism approaches maturity. Also used to represent growth of language, of understanding, or of some skill. Development resulting largely from hereditary factors is often referred to as *maturation*. This may be contrasted with development resulting largely from the learning process.
- developmental psychology** The study of psychological development. Also referred to as *genetic psychology*.
- deviation I.Q.** A statistically derived I.Q. of the same order as a standard score. In contrast with the conventional I.Q. ( $M.A./C.A. \times 100$ ), it is determined by the standard deviation of the distribution of M.A. scores at a given age level and the deviation of the individual score from the mean of this distribution.
- dexterity** Skillfulness, expertness, versatility. The person who uses both hands equally well is said to be ambidextrous, to possess ambidexterity.
- diastolic blood pressure** That associated with the dilatation of the ventricles of the heart. It is lower than the systolic pressure, associated with heart contraction.
- difference threshold** The smallest perceptible difference between two stimuli. See *j.n.d.*
- differential aptitude test** A special test, based upon factor analysis, which measures several aptitudes at the same time. Abbreviated DAT.
- differential conditioning** Conditioning in which the organism discriminates between stimuli, giving a conditioned response to one and not to the other which has been paired with it.
- differential forgetting** Selective forgetting, especially of erroneous responses faster than correct ones.
- differential response** One that is discriminatory.
- differentiation** The change from generalized to specific structures or functions as when what was once a budlike structure becomes a hand with its integral mechanisms. Also used as synonymous with discrimination as when what was once reacted to as a whole, or in a nondescript way, is reacted to in terms of its constituent parts. In *conditioning*, the change from an overall response to a specific response (like lifting the foot instead of merely struggling) or responding differently (differentially) to two tones which were at first each reacted to in the same way.
- digit span** The memory span for digits. See *memory span*.
- direction set** A continuing attitude or assumption which leads the associations of the thinker to follow a certain line.
- direction of conditioning** The tendency for the conditioned response to be congruent with the total situation, or with the needs of the organism. For example, it is salivation and not pricking up the ears which comes to be associated with a sound presented with food.
- directional cues** External stimuli which provide guidance as to the direction of food, escape, and so forth.
- discrimination** Responding differentially, as when an organism makes one response to a reinforced stimulus and another response to a stimulus that is not reinforced.
- disparity, retinal** The difference in the retinal images when an object is viewed with the left and with the right eye.
- displacement** Emotional; anxiety focused upon something other than its real cause. Also aggression toward a person or object other than the one causing the anger — e.g., the man, angry with his wife, who "picks on" a child, an underling, or even an inanimate object (kicking or breaking it). The anger (or aggression) is then said to be *displaced*.
- dissociation** Separation of ideas or of responses normally associated; like being unable to recall one's name; being able to write, yet without awareness of what one is writing; having two or more different personalities, e.g., Dr. Jekyll and Mr. Hyde.

- dissociation by varying concomitants** The individual confronted by many different things (like different kinds of dogs) comes to overlook (dissociate) the differences and to discern something which all, despite their differences, have in common. Basic to development of concepts.
- distraction** Having attention diverted from what one is doing.
- distributed effort** Learning with small units of work and/or interpolated rest periods. Contrasted with massed learning, where the individual works continually until the skill is mastered.
- dominance** In heredity, a trait is said to have dominance when it depends upon the presence of one gene (the dominant) which suppresses the effects of its partner (the recessive). Cortical (hemispheric) dominance refers to the dominance of one side of the brain (usually the left) in control of handedness and speech.
- dominance hierarchy** A social situation in which one organism dominates all below it, the next all below it, and so on down to the organism dominated by all. A pecking order in barnyard hens.
- dominant gene** See **dominance**, above.
- dorsal columns** Those toward the back.
- double alternation problem** One in which the organism is required to make a *rrll*, or some comparable sequence of turns, in a temporal maze.
- dreaming** The fantasy which, as distinguished from that of day-dreams, takes place while one is asleep.
- drive** A physiological condition which impels the organism to become active. Distinguished from a motive in being initially indiscriminate, without an appropriate direction.
- drive reduction** Alleviating tensions associated with drives.
- dual personality** What is apparently two persons in one, as in Dr. Jekyll and Mr. Hyde.
- duplicity theory** The theory (now accepted as fact) that there are two kinds of visual receptors, the rods for achromatic and the cones for color vision. See **rods** and **cones**.
- dynamics** This term is used in psychology to refer to the underlying and changing bases of behavior such, for instance, as motives. A dynamic approach is one which deals with change (or with changing forces) as in group dynamics. See **group dynamics**.
- dynamometer** An instrument with which we measure the force exerted in the performance of some act. A hand dynamometer measures strength of grip.
- ectomorphy** Dimension of body build characterized by predominance of skin and nervous mechanisms.
- educational psychology** The field having to do with application of psychology to educative processes, such as the teaching of the school subjects.
- effectors** Muscles and glands.
- efferent neuron** That with motor functions.
- ego** The individual's conception of himself. Also, in psychoanalysis, that part of the personality which, as an outcome of reality-testing, restrains the expressions of the id.
- ego-defensive** Compensatory, maintaining self-esteem under conditions which threaten it.
- ego-involvement** Being personally wrapped up in some person or situation, as when the parent feels that his child's triumphs or defeats are his own or that his own performance in some situation will raise or lower his status in the group.
- eidetic imagery** Imagery of such clearness that the objects represented appear in some respects to be present. Similar to hallucinations but believed to be normal in many children at early age levels.
- Electra complex** A term used by Freud to represent the erotic attachment of a daughter for her father, with concomitant jealousy of the mother. This attachment may be repressed and disguised in various ways. See **complex** and also **Oedipus complex**.
- electric-shock therapy** Also referred to as electroconvulsive therapy (abbreviated E.C.T.) and electroshock therapy. Attempting to relieve such symptoms as extreme depression by passing a weak electric current through the brain from electrodes applied to the scalp. Passage of the current through the brain produces widespread convulsions.
- electronic brain** A highly complex machine, utilizing electron tubes, which stores and

- utilizes information in such a manner as to suggest some of the functions of the human brain. A "thinking machine."
- electrocardiogram** A record of the various phases of heart activity derived from electrical concomitants of this activity.
- electrodermal changes** Changes in the electrical conductivity of the skin.
- electroencephalogram (EEG)** A record of electrical rhythms associated with some brain activities. Recorded with an *electroencephalograph*.
- emitted response** Coming without an external stimulus, i.e., spontaneously.
- emotion** A condition underlying such experiences and actions as occur in fear, rage, and the other so-called emotions. In its most obvious manifestations it is an acute condition characterized by disruption of everyday experiences and activities.
- emotional maturity** Being grown-up emotionally, not being swayed by childish motives. Sometimes referred to as *social maturity*.
- encapsulated end-organs** Skin receptors enclosed in a capsule-like structure.
- encoding** Transforming a message into a code (or set of signals) from which it can subsequently be translated to convey information. For example, putting a message into Braille, into electrical impulses as in Morse code, and so on. See *decode*.
- endocrine glands** Those which pour their products (hormones) directly into the blood stream. The ductless glands.
- endolymph** Liquid contained in the semicircular canals and vestibule of the inner ear.
- endomorphism** The dimension of body build characterized by predominance of fat, especially in the abdominal region.
- engram** Altered state of living tissue responsible for memory. Sometimes used as a synonym for *neurogram*.
- environment** Everything which surrounds the units of inheritance. There is the *intracellular environment* (that within the cell) the *intercellular environment* (that involving the effect of cell upon cell), the *prenatal external environment* (that surrounding the embryonic or fetal organism) the *internal environment*, that within the organism, such as the blood; and the *external environment*, which is what we usually think of as *the environment*, and which includes the *social* or *cultural environment* as well as the purely physical, like light and air. *Psychological*, in terms of what it means to the individual.
- epilepsy** Disorder characterized by convulsions and loss of consciousness.
- equilibrium** See *static sense*.
- eroticism** Sexually derived pleasure. The Freudians extend the term to cover pleasures derived from anal and oral as well as genital stimulation.
- escape training** This occurs in the situation where, by making a certain response (i.e., pressing a lever), the organism terminates punishment. Compare *avoidance training*.
- estrin** A secretion from the ovaries which plays an important role in female sexual development, including the sex drive.
- estrogens** Hormones from the ovaries. See *estrin*.
- Eustachian tube** A tube connecting the middle ear with the throat and which has much to do with maintaining normal air pressure in the middle ear.
- excitability** Property of organisms which enables them to respond to stimulation.
- exercise, in learning** Repetition of learning activity.
- experience** Used to represent what has been referred to above as *conscious experience* (like awareness of the world about us) and also to represent what has happened to an organism in the past, in the sense of *past experience*.
- experimental extinction** Elimination of a learned response by arousing but failing to reinforce it.
- experimental introspection** Describing one's experiences under controlled conditions of the laboratory.
- experimental method** Variation of environmental, physiological, or attitudinal factors in order to observe dependent changes in aspects of experience and/or behavior.
- experimental neuroses** Behavior disorders produced experimentally, as when an organism is required to make a discrimination of extreme difficulty and "breaks down" in the process.
- experimental psychology** Experimental investigation of psychological problems.

- explicit** Directly expressed, observable, objective. Overt.
- exploratory drive** The urge to explore, to examine, to probe in strange situations. Perhaps comparable, in apes and men, with curiosity.
- external ear** The outer ear as far in as the eardrum.
- external environment** The environment which surrounds the individual, that external to him.
- external response** A response of the musculature which is readily observed without instruments, like walking, typing, or speaking.
- extinction, experimental** Eliminating a learned response by arousing but failing to reinforce it.
- extraversion** Term which represents the tendency to be outwardly expressive, as in talking a lot, being excessively active, and engaging in social activities. The other extreme from introversion.
- extravert** Person with a high degree of extraversion.
- face validity** Apparent validity as distinguished from statistically established validity.
- facial vision** Alleged ability of blind people to avoid obstructions through tactual stimulation of the face by air currents.
- facilitation** Process of making something possible of accomplishment or easier than it might otherwise be. *Neural* — making more ready the passage of impulses across a synapse.
- factor analysis** A statistical procedure aimed at discovering the constituent irreducible traits in what is complex, as in the case of intelligence or personality.
- factors** Component or constituent parts or conditions. In intelligence or personality, the constituent aspects revealed by factor analysis.
- false recognition** Seeming to recognize or to remember somebody or something actually seen for the first time. French, *déjà vu*.
- fantasy** Imagery that is more or less coherent, as in dreams and daydreams, yet without due regard to reality.
- fear** An emotion characterized by unpleasant feelings, tension, and, where possible, avoidance or flight. There is also marked involvement of the autonomic nervous system.
- feeble-mindedness** A level of intelligence represented by an I.Q. of 70 or less.
- feedback** The return of impulses to a control center where they play a part in further control, as in the case of impulses produced by muscular activity returning to the brain, informing it of the posture of the muscles, and thus contributing to further control of these muscles. It is comparable, in a sense, with the functions of a governor on a steam engine, which feeds back the information that more or less steam is needed.
- feeling** Affective experience reported by the individual as pleasantness, unpleasantness, excitement, calm, tension, sadness, happiness, and so forth.
- figure and ground** Where one part of a situation is seen as a shape with the rest of the situation as background, like an airplane seen against the sky.
- fistula** A tube inserted into an opening in the body. As we used the term, a tube through an opening in the stomach so that liquid could be inserted directly.
- fixated response** One that has been so firmly established that it is difficult to eliminate. See *fixation*.
- fixation** The becoming firm or stable or inflexible of some aspect of behavior — like the firm acquisition of some habit. Used in abnormal psychology to refer to the retention to a later age of some infantile trait, like oral eroticism.
- fixed interval reinforcement** A schedule which makes the reward available at the end of consecutive intervals; say every 20 seconds. See *reinforcement*.
- fixed ratio reinforcement** A schedule which rewards the last of each of a given series of responses; say, every fifth or every tenth response regardless of the intervals involved. See *reinforcement*.
- flight of ideas** An incoherent succession of ideas such as often occurs in mania, where the person's verbalizations go off on any tangent which suggests itself.
- fluctuation of attention, or of perception** Pe-

- riodic changes in clearness, as when what was figure becomes ground, and vice versa, and what was heard is no longer heard.
- force of habit** Habits which might have been changed persist with such force that the person seems "in a rut." There is strong motivation to hold onto habits already present rather than to change them.
- forgetting** Loss of ability to recall; extinction of what has been learned.
- formal discipline** The doctrine, now rather generally discredited, that the study of certain difficult subjects like mathematics and Greek improves the intellect more than the study of other subjects in the curriculum. These subjects were assumed to "discipline the mind." Actually, diligent study of mathematics, Greek, and similar subjects, often provides skills of value in other studies.
- formboard** A test device which calls for fitting blocks of various shapes into their proper holes, or into proper relationship, one with the other.
- fovea** A small depression in the retina which is also the area of sharpest vision. It contains only cones.
- foveal vision** That involving the fovea.
- fraternal twins** Distinguished from identical twins in that they have different hereditary characteristics and may also differ in sex. Derived from different ova, hence *binocular twins*.
- free association of ideas** Letting thoughts or words come as they may, as contrasted with controlled association, where certain directive tendencies are introduced.
- free-floating anxiety** Anxiety focused upon nothing in particular.
- free nerve endings** Branching ends of afferent fibers which are not embedded in receptors. Contrasted with the encapsulated nerve endings also found in the skin. They mediate pain and some aspects of pressure sensitivity.
- frequency**, as a factor in learning. The idea that, other things (including motivation) being equal, the more often a response is made to a situation the greater the tendency for this situation to arouse it in the future. Same as *principle of exercise*.
- frequency distribution** A distribution of data showing the number of times (frequency) that each consecutive score is made.
- frequency principle** This is based upon the observation that, within certain limits, an increased intensity of stimulation increases the number of impulses which travel along a nerve fiber in any given time interval. Within limits, then: *An increased intensity of stimulation produces more frequent nerve impulses*. This is the frequency principle. It is assumed to underlie the intensive aspects of experience — brightness, loudness, and so on. But also see the *frequency theory of hearing*, which attempts to correlate the frequency of nerve impulses not with an intensive aspect of hearing (loudness), but with a qualitative aspect (pitch).
- frigidity** Extremely weak sexual motivation in women.
- frontal lobes** Those at the front of the brain, just behind the forehead.
- frustration** State of organism resulting when the satisfaction of motivated behavior is rendered difficult or impossible.
- frustration tolerance** Ability to withstand a great amount of frustration without developing inadequate modes of response, like "going to pieces" emotionally, or becoming neurotic.
- fugue** Literally, a flight. Applied to neurotic behavior involving some episode (leaving home, a crime) which the individual, when he recovers, is unable to recall.
- functional autonomy** The tendency of habits to continue even though the motivation which led to their acquisition is no longer present. Different from *force of habit* in that the original motivation has ceased to exist.
- functional disorders** Those with no known organic basis; dependent upon prior experience rather than structural defects.
- functional psychology** The school which argued, against the Structuralists, that psychology should concern itself with what the processes of mental life do, and not merely with their conscious "structures," like sensations, images, and feelings.
- fungiform papillae** Structures at the sides and tip of the tongue which contain taste receptors.

- galvanic skin reflex (GSR)** Lowered resistance of the skin to passage of an electrical current following emotional and other forms of stimulation. Recorded with the psychogalvanometer.
- ganglion** A nerve cell. Plural **ganglia**. Groups of nerve cells.
- ganglion cells** Retinal cells of the fibers whose axons become the optic nerve.
- gastrointestinal** Pertaining to the stomach and intestines.
- general intelligence** The overall intelligence of a person as represented by his general flexibility of adjustment. The term was also used by Spearman (in his concept of *g*) to represent an alleged general ability, or capacity, which expresses itself through special skills, like the social, mathematical, mechanical, and so forth. Sometimes related to the individual's ability to deal with abstractions.
- general poresis** See **poresis**.
- general psychology** The study of psychology in the large without emphasis on animals, children, adults, or special processes like the sensory processes, learning, etc. Often used to mean an introduction to the problems, methods, and principles as represented in textbooks for the beginner.
- generalization** A general conclusion, theory, hypothesis, or concept based upon certain facts or observations.
- generalized response** An overall as compared with a specific response.
- generalizing** Reasoning in such a way as to arrive at a generalization.
- general adaptation syndrome** A term coined by Selye to represent certain compensatory (homeostatic) reactions of organisms to organic and mental stress. By *syndrome* is meant a particular group of symptoms characterizing a disease or other condition, in this case characterizing adaptation to stress. According to Selye, the anterior pituitary and the adrenal glands are important factors in this syndrome (abbreviated G.A.S.)
- genes** Determiners of inheritance located within the chromosomes.
- genetic method** Studying development by observing the growth of an organism continuously or through comparison of stages.
- genetic psychology** Psychology which studies the evolution or growth of psychological processes, using the genetic method.
- genius** A person with exceptionally high intelligence. The person is said to approach this level if his I.Q. is 140 or above. Also an individual with some very unusual talent or ability that is recognized by society.
- Gestalt** Form or configuration.
- Gestalt psychology** The school which disparages the analytic approach to experience and behavior and argues for emphasis upon wholes which, Gestalt psychologists say, are more than the sum of their parts. In learning, this school emphasizes insight as opposed to trial-and-error; in perception it stresses the organizations, which appear to be independent of past experience, such as figure-ground relationships and the phi-phenomenon. The word *Gestalt* is often translated as *configuration* or *form* and the school is sometimes referred to as *configurational*, i.e., as emphasizing configurations rather than their constituent parts.
- gifted** Persons with special talents. Used, also, to represent individuals with an I.Q. of 130 or above (i.e., Terman's gifted children).
- glands** Secreting organs, like the tear glands (duct) and the adrenal glands (ductless, or endocrine).
- glottis** The opening between the vocal cords, at the upper end of the windpipe.
- glycogen** Sugar released by the liver.
- goal objects** Incentives to motivated behavior.
- goal orientation** Behavior directed toward a goal.
- gonads** Sex glands, ovaries in females and testes in males.
- graphology** The attempt to assess personality and character through handwriting.
- grasping** Reflex gripping of an object with the hand such as occurs in infancy; also the later-appearing prehensile variety, where the individual reaches for and takes hold of an object.
- gray matter** Neural substance of the spinal cord and brain composed largely of cell bodies; the cerebral cortex is almost entirely gray matter.
- gregariousness** The tendency to associate with others.

- grooming** Exploring the skin and hair for foreign objects, as practiced by monkeys and apes.
- group behavior** Activities characteristic of congregations of organisms, such as family behavior, crowd behavior, and behavior in an audience.
- group dynamics** A term used by followers of Lewin and others to represent the study of underlying features of group behavior, such as field forces, motives and the like. It is concerned with group change rather than with static characteristics.
- group mind concept** The idea that something emerges in a group situation which is more than the reactions of individuals as such. This is referred to as the "group mind" or the "collective mind."
- group tests** Those designed to be administered to more than one individual at a time.
- group therapy** Having the patient discuss his problems with others and with the psychiatrist or counselor, all of whom meet in a group.
- guidance** Used to differentiate vocational guidance from vocational selection. In guidance, the individual is given advice concerning vocations for which he may best be fitted.
- guided performance** The organism is put through some performance to be learned rather than left to its own resources.
- gustation** The sense of taste.
- gustatory** Pertaining to taste.
- habit** An acquired mode of behavior, such as a motor or verbal skill, a way of doing things, or a way of thinking. The learning process is sometimes referred to as *habit formation*.
- habit hierarchy** A complex learned response (like typing) which involves an integration of simpler habits (like letter habits, word habits, etc.).
- habit interference** Otherwise known as *negative transfer*, where the acquisition of one habit interferes with the later learning of another.
- habitual** Derived from what one has learned; also, customary. Habitual set, for example, is a customary or usual set derived from earlier experience.
- hallucinations** False perceptions which differ from one individual to another (as distinguished from illusions, which are typically alike in all) and which have the appearance of reality. For example, one alcoholic sees red devils coming at him, another sees snakes, another hears accusing voices, and another feels bugs crawling on his skin.
- hammer** Small ossicle of middle ear attached to the eardrum.
- hebephrenia** A variety of schizophrenia characterized by silliness.
- helicotrema** An opening in the basilar membrane at the apex of the cochlea, where the ascending and descending canals connect.
- Helmholtz theory of audition** The auditory theory which correlates pitch with the region of the basilar membrane maximally activated by a sound frequency. Also known as a *place theory*, *piano theory*, and *resonance theory*. (For Helmholtz theory of vision, see Young-Helmholtz theory of vision.)
- hereditary** Referring to that which is inherited, or dependent upon the genes.
- heredity** What is passed on from parents to offspring biologically through the genes. *Social heredity* refers to nonbiological transmission of habits and ideas, through cultural contacts.
- hierarchy** Organization of habits, concepts, or the like, in which simpler components are combined to form increasingly complex integrations.
- hieroglyphic writing** The type of picture writing used by the Ancient Egyptians, where a picture (sometimes quite abbreviated) represented an object and sometimes merely the syllable or sound which, with others, composed a word.
- higher-order conditioning** Stimuli already made effective through conditioning are used to condition further responses, much as unconditioned stimuli are used.
- histogram** A series of rectangles representing a frequency distribution. The height of each rectangle indicates the frequency of a particular score—i.e., the number of times that this score occurred.
- holistic assessment** Emphasis upon the entire person functioning in social situations;

- contrasted with a piecemeal or analytic approach in terms of traits.
- homeostasis** The compensatory mechanism whereby a constant state is maintained. Physiologically exemplified by sweating and other processes which maintain a constant body temperature when the external temperature is high. *Psychological homeostasis* may be illustrated by maintaining one's self-respect (in the face of failure) through such compensatory devices as rationalizing, blaming others, etc. It is also exemplified when the output of a fatigued person is maintained at a high level through closer attention or increased effort.
- horizontal plane** That which, like the horizon, runs at right angles to the vertical.
- hormones** Chemical products of the endocrine glands, like adrenalin and estrin.
- hue** The characteristic of visual experiences related especially to the wave-length characteristic of light waves — e.g., red, green, yellow and blue; i.e., *color* in the everyday sense of the word.
- human nature** Those overall characteristics of human beings which depend upon their inheritance of human genes. Biological as distinguished from acquired nature.
- hunger** Motivation and experience associated with delayed satisfaction of the need for food.
- hunger pangs** Otherwise known as *hunger pains*, the painful contractions of the stomach musculature during intense hunger.
- hybrid** An organism resulting from a sperm and ovum differing in one or more gene pairs, like *rw*, or *Bb*. Also the result of a cross between two species, e.g., the mule resulting when a horse and a donkey are crossed.
- hydrocephalic** Pertaining to excess fluid in the brain which causes the skull to become greatly enlarged and which interferes with normal brain development, usually leading to feeble-mindedness.
- hyper-** Above.
- hypnosis** A trance-like state brought on through suggestion that the individual is to relax his muscles, sleep, and carry out various acts under the control of the hypnotist. Literally a "nervous sleep."
- hypo-** Below.
- hypoglycemia** Lower than normal blood sugar level.
- hypothalamus** The under side of the thalamus containing neural mechanisms which play an important role in emotion, sleep, and other physiological functions.
- hypotheses** Ideas, suppositions, tentative conclusions.
- hypothyroidism** Condition in which there is a less than normal secretion of the thyroid hormone, thyroxin.
- hysteria** General term for functional disorders characterized by anxiety without sufficient cause, and such forms of dissociation as amnesia, fugue, functional anesthesia, functional paralysis, and multiple personality.
- id** Freudian term representing the unconscious (or subconscious) primitive urges which underlie behavior.
- idea** The term is variously used, but always with reference to some implicit representation of things or relationships; synonymous with what we have called *symbolic processes*. It may mean something of which one thinks — like getting the idea to look up something in a book — or an image, as when a person thinks of his mother. Concepts may also be referred to as "ideas."
- identical twins** Those derived from the same ovum; hence sometimes called *uniovular*.
- identification** The process whereby an individual becomes ego-involved with persons or things — their problems are his problems, criticizing his school is criticizing him.
- idiot** Person in the lowest intelligence bracket — with an I.Q. lower than 25.
- illusion** Name given to a perception which is considered as mistaken because it does not agree with some other experience, such as objective measurement, which is taken as more fundamental.
- image** An implicit (internal) representation of past experience; in optics, figure of an object formed by light rays; in sensory psychology, the impression which remains after an external stimulus has been removed, i.e., a *positive* or *negative after-image* in vision.
- imagery** The reviving of past experiences implicitly, i.e., in the form of images.



**imbecile** Person in the middle range of feeble-mindedness, with an I.Q. between 25 and 50.

**imitation** Copying (perfectly or imperfectly) some act that has been witnessed.

**immobility (tonic)** Remaining perfectly still, as in a so-called "death faint" or in what is otherwise called "animal hypnosis."

**impairment** Deterioration of function, decreased efficiency.

**implicit response** One not directly observable but inferred from relevant facts. Brain processes are implicit because we do not observe them directly; thought processes are, for the same reason, said to be implicit. Contrasted with *explicit*, or directly observable.

**impotence** Want of strength or vigor, as in sexual impotence where sexual vigor is lacking. In females the term *frigidity* is more often used.

**imprinting** A learning process observed in some birds, and possibly other animals, that occurs with extreme rapidity and at an early "critical stage" of development. It involves the socialization of an instinctive response; such, for example, as following a moving object. In our example, the subjects were goslings. The imprinting object would normally be the mother. In her absence, however, the goslings came to follow a man, or a model of a goose. Imprintability reached a maximum during the first day after hatching. Responses acquired in this way are apparently persistent and irreversible. Thus, the gosling imprinted upon its mother never follows a man (or model) and vice versa.

**incentive** An end or object of motivated behavior. That which is sought after — like food, a sex object, or money. Contrasted with *deterrent*. Could also be a consummatory act, e.g., to copulate, urinate, exercise, or play.

**incidental learning** Sometimes referred to as *passive learning*, i.e., learning incidentally, without trying. Also see *latent learning*.

**independent variable** The variable manipulated by the experimenter — e.g., the intensity of light, the hunger of an animal, or the presence or absence of a rest-pause in learning.

**index of differentiation** One representing the discrepancy between a personal attitude (expressed in a projective questionnaire) and an overt attitude (as revealed in direct responses to questions).

**individual differences** Deviations of individuals from the average or from each other.

**individual tests** Administered to one person at a time.

**inference** Suggestion, guess, hypothesis, or judgment based upon certain data but not directly evident, as the inference (to be tested) that one's car has stopped because it is out of gas.

**inferential** Based upon inference.

**information** Knowledge, however acquired, including such things as clues in problem solving and cues in a learning situation. However, this term has a very different meaning in information theory, where it means reduction of uncertainty in a particular situation. The measure of this is the *bit*. See *bit* and *information theory*.

**information theory** Not really a theory, but a system for studying the communication process. It involves the detailed analysis, often mathematical, of all aspects of the process which involves the encoding, transmission, and decoding of signals. It is not concerned, in any direct sense with the meaning of a message, with what it means to the receiver. Of all possible signals which might be transmitted, relative to a particular message, those which reduce uncertainty by one half are assumed to convey one *bit* of information. See *bit*, *redundancy*, and *noise*.

**informational feedback** See *knowledge of results* and *feedback*.

**inhuman** Below the human level.

**infra-red** Below the frequency of red light, or of greater wave length (over 700 millimicrons).

**ingroup** The group to which one belongs. One's family is an ingroup, one's club, one's nation.

**inhibit** Check, hold back, or prevent.

**inhibition** The complete or partial arrest of an activity or process.

**innate** Inborn, or inherited.

**inner ear** The innermost part, which contains the cochlea and the semicircular canals.

**insanity** Legal term for mental illness of such

- severity that the individual cannot be held responsible for his acts. The psychiatric term is *psychosis*.
- insight** Sudden understanding, as when one "sees through" a situation or "gets the idea." Also inferred from sudden improvement in learning.
- inspiration** Similar to insight; a sudden grasping of the solution to a situation, the sudden occurrence of an idea. Dealt with as a stage in creative thinking.
- instinct** A descriptive term for a complex unlearned adaptive response; or an unlearned pattern of reflexes. If the adjustment were learned the behavior pattern would be called a habit.
- instinctive** Originating in instinct.
- instructional set** One that is verbally induced, as in telling a subject that he will see pictures relating to animal life, or that he is to respond to red but not to green.
- instrumental conditioning** That in which the conditioned response is instrumental in achieving some end, like obtaining food or escaping punishment.
- instrumentation** Learning which involves the invention or utilization of instruments, as when a chimpanzee solves a problem by joining sticks and using them.
- insulin** A secretion from the Islets of Langerhans (in the pancreas) that is necessary for carbohydrate metabolism. An undersecretion is responsible for diabetes and the related symptoms. Hyperinsulinism (an oversecretion of insulin) can produce hypoglycemia. See *hypoglycemia*.
- insulin shock therapy** Injection of insulin in sufficient quantity to produce a coma, from which the patient recovers through administration of glucose. Used in treating certain psychotic conditions.
- integrate** To bring together diverse things so that they form a functional whole.
- integration** A bringing together in some meaningful or workable relationship; the process of coordinating, as in *neural integration*.
- integrative process** The process of integrating, as when the cortex brings together different kinds of information (visual, auditory, and so on) so that the resulting reaction is consonant with the circumstances that exist.
- intelligence** Flexibility or versatility of adjustment, especially exemplified in ready adjustment to new situations.
- intelligence quotient** In its original meaning, the ratio of a subject's mental age (as determined by a standard comparative test) to his actual age, and multiplied by 100 — i.e.,  $M.A./C.A. \times 100$ . But also see *deviation I.Q.*
- intensity** The *quantitative* as contrasted with the qualitative aspect of stimulation or experience; for example, the magnitude, amount of pressure, or amplitude of a sound wave as distinguished from its frequency, and the brightness of a color as differentiated from its hue.
- intensive** Having to do with intensity. *Quantitative*.
- intention** The aim or purpose to do something.
- intentional** Done with intent, purposefully.
- interaction process analysis** Analysis of small group behavior in terms of twelve categories — viz., shows solidarity, shows tension release, shows agreement, etc.
- interest** An attitude favorably disposing one toward some object, situation, or idea.
- intergroup relations** Relations of one group with another.
- internal environment** That within the organism, especially as represented by characteristics of the blood.
- internal stimuli** Those originating within the organism.
- interpersonal relations** Relations of individuals interacting with each other. For example, the relations which exist between husband and wife, employees and the management, and so on.
- interpolated activity** That which, as in the retroactive inhibition experiment, comes between the original learning and recall, or relearning.
- interposition** A monocular (and psychological) cue in visual space perception involving the overlapping, or partial obscuring, of objects as seen.
- intersensory** Involving more than one sense.
- interstimulation** A reciprocal social relation where what one person does stimulates another, whose behavior in turn serves as a stimulus. Observed in any conversation

- where what one person says is the stimulus for a reply from the other and that for a further response from the one who initiated the conversation.
- interval scale** Like that of the temperature scales, where the intervals are equal, but there is an arbitrary zero point.
- intervening variable** An event inferred to occur within the organism between the moment of stimulation and that of response in such a way as to determine or influence the response. This could be an inferred neural response (such as neural inhibition) or some psychological response (like the expectation that the act will have certain consequences).
- introsensory** Within the same sense.
- introspection** Looking inward, so to speak, and describing one's experiences.
- intraversion** A tendency to be overly concerned with one's thoughts, to be inwardly reflective or introspective rather than overtly expressive. The opposite pole from extraversion.
- introvert** One with a high degree of introversion.
- invagination** Turning or folding inwardly, as on the surface of our cerebrum.
- involuntary** Without intention, without personal control.
- involutional melancholia** Psychosis sometimes associated with the menopause (involution) and characterized by depression.
- iris** The flat circular muscle which controls the amount of light admitted to the retina. It is situated in front of the lens and is responsible for the eye's color.
- irradiation** Spreading of the effects of stimulation such as Pavlov assumed to underlie stimulus generalization in conditioning.
- Ishihara test** A series of charts designed to detect the color weak or color blind.
- isolate** A person who, in a sociometric study, is chosen by nobody. He stands alone in a sociogram.
- J-curve** A frequency curve often found when data for situations in which one is expected to conform are plotted. Instead of resembling a normal distribution, the plot is one in which most individuals are represented to the left and fewer and fewer toward the right. The graph thus looks like a reversed J (J). Our example in this text dealt with conformity in children's attitudes. Public expressions of attitude gave a J-curve while private opinions (as revealed projectively) gave something closer to a normal curve.
- James-Lange theory** The theory that the feeling aspect of emotion is an experience of bodily changes, like the activities of the viscera and of the skeletal muscular structures.
- job analysis** Studying a job in such a way as to discover its components and its psychological and other requisites.
- just noticeable difference** (j. n. d.) The smallest discriminable (or perceptible) difference between stimuli.
- kinesthesia** The muscle or movement sense, mediated by the receptors in the muscles, tendons, and joints. See **proprioception**.
- knee jerk** A reflex kick of the foot following a blow on the tendon just below the knee cap.
- Krause end-bulbs** Structures in the skin assumed at one time to mediate sensitivity to cold.
- Kuder Preference Record** An inventory designed to discover the degree of interest that an individual has in various areas of everyday life — like the mechanical, the scientific, and the social.
- kymograph** Apparatus designed to record variations in activity as a function of time. The most common form is a rotating drum containing a strip of smoked paper on which marks are made by a recording stylus.
- laissez-faire situation** One in which each individual does as he pleases. Its relevance here is with respect to the study of social climates, one of which was laissez-faire. Compare **authoritarian** and **democratic**.
- language** Communication through conventionalized gestures or spoken or written symbols.
- larynx** The upper part of the windpipe — a cartilaginous box containing the vocal cords. The "voice box."
- latency** The period of apparent inactivity be-

- tween the time that the stimulus is presented and the moment that a response occurs.
- latent learning** That not evident to the observer at the time when it occurs. It is inferred from later performance in which learning is more rapid than would be expected without an earlier acquisition of relevant information. See **incidental learning**.
- lateral plane** From side to side, including the positions right, down, left, and up.
- learning** A more or less permanent modification of behavior which results from activity, special training, or observation.
- learning curve** Changing skill or ability, plotted as a function of trials, or practice.
- learning sets** Learning "know how." Learning how to learn. Exemplified when an organism learns each successive problem (of equal or greater difficulty than earlier ones) in fewer trials.
- lens** A structure behind the iris of the eye which is involved in changing the focus of light on the retina. Known as the **crystalline lens**.
- leptosome** Thin, slender, asthenic, ectomorphic.
- lethargy** Inertness, apathy, lack of motivation.
- leveling** Reduction in the content of a rumor as it passes from mouth to mouth. The mentioning of fewer items.
- level of aspiration** The level of performance which the individual desires to reach, or which he feels that he can achieve.
- libido** According to Freud, sexual energy — an erotic force motivating behavior.
- lie detector** Device for recording changes in respiration, blood pressure, and the electrodermal response while the person is questioned about some crime or asked to give associations for relevant and irrelevant words.
- life goal** What one wishes to become; his ambition.
- life space** The individual and his environment at any moment, as he perceives it. See **topology**.
- linear perspective** Perception of the distance of objects through an apparent convergence of lines and a decrease in size with increasing distance.
- linguistic** Having to do with language.
- lobes** Main divisions of the human brain, like the frontal and temporal lobes.
- locomotion** Moving from one place to another. In Lewin's topological psychology it also refers to imagined or anticipated change and even to change in attitude or change in status.
- longitudinal study** A study which follows the same individual from early to later age levels. Contrasted with cross-sectional studies, in which different groups represent each age level.
- loudness** The intensity aspect of auditory experience scaled in decibels.
- love** A feeling of attachment or affection for some person or thing, not necessarily sexual.
- maladjustment** Adjustment that is faulty, poor, inadequate, abnormal. See **adjustment**, also **abnormal**.
- mammals** Animals that carry their young in the uterus and suckle them after birth.
- malinger** Feigning sickness or disability.
- mand** The function of certain words is that of demanding or requesting something. A word, phrase, or sentence serving this function is called by Skinner a **mand**, from **demand**.
- mania** An exceptionally excited state found in manic-depressive psychosis.
- manic-depressive psychosis** A grave functional mental illness characterized by periods of mania and depression which alternate in different ways, depending upon the person afflicted.
- manipulation** Moving things around, as with hands or mouth.
- manual** Pertaining to hands — manual dexterity or skill and manual labor refer to functions performed primarily with the hands. The manual alphabet used by the deaf and dumb is a system of signs made with the hands.
- mass activity** Overall activity, generalized.
- mass media** Communication media like newspapers, magazines, radio, and television.
- mass movement** A change, or attempted change in social life that involves many people. Large numbers of people going in a new social direction, as in the case of the Nazi movement in Germany.

- massed learning** Learning without interpolated rest periods.
- mastery motive** The urge to be assertive, to stand out in the crowd, to be dominant.
- maternal drive** The urge to care for the young.
- maternal instinct** An unlearned stereotyped pattern of caring for the young which is found in some animals.
- maturation** Development depending solely upon biological conditions which characterize the race, as distinguished from learning which, although it is somewhat dependent upon the level of maturation attained, requires exercise, practice, or observation of the performance of others.
- maze** Often used in the study of learning. Device with a more or less complex pathway having blind alleys in which the subject can get lost, or at least expend unnecessary time and energy.
- mean, arithmetical** The average score; the sum of the scores divided by the number of cases.
- meaning** The significance of something to the subject; such as its use, its origin, its association with other things.
- mechanical comprehension test** Designed to measure one's familiarity with and understanding of mechanical facts and principles.
- median** The middlemost score in a series arranged in rank order.
- median plane** That which cuts vertically between the ears.
- medical psychology** Methods and procedures of psychology having applications in the field of medicine and aspects of medicine relevant to psychology.
- Meissner's corpuscles** The so-called "touch corpuscles" in the skin which are believed to be receptors for light pressure.
- memory** Retention of what has been learned. It is evidenced by later recall or reproduction, recognition, or relearning with a savings. Also see **biological memory** and **engram**.
- memory drum** A rotating drum designed to expose, one unit at a time, and for a controlled interval, what is to be memorized.
- memory span** The maximum number of items (words, syllables, digits) recalled after a single presentation, whether auditory (auditory memory span) or visual (visual memory span).
- memory trace** A term representing the neural modification inferred to underlie memory. An engram.
- menopause** The end of menstrual or reproductive life.
- mental** In its original sense, pertaining to the *mind*. Now used with reference to the adjustments of organisms to their environment, and especially those adjustments which involve symbolic functions and of which the individual is aware.
- mental age (M.A.)** The degree of intelligence exhibited by an individual in relation to others of his age group. He is said to have an M.A. of 8, for example, if he does on standardized intelligence tests, what the average child of 8 can do. His actual age (C.A.) might be greater or less than his M.A.
- mental hygiene** Concerned with the preservation of mental health. Emphasis is given to child training and to education concerning normal methods of adjustment.
- mental philosophy** Branch of philosophy dealing with psychological problems.
- mental set** An implicit readiness to perceive some particular thing, like the geologist's readiness to notice rock formations of which others are oblivious.
- mental tests** General term sometimes used for all psychological tests, and especially for those measuring intelligence.
- mesmerism** Early name for hypnosis, as practiced by Mesmer.
- mesomorphy** Tendency toward muscularity.
- microcephalic** A person with an especially small head, usually at the idiot level of intelligence.
- mind** A general term representing the sum-total of all intelligent behavior, including memory, thought, and perception. Often used as synonymous with conscious experience.
- minimal cues** abbreviated aspects of a total situation, reduced cues, hints.
- Minnesota Multiphasic Personality Inventory (M.M.P.I.)** Statements pertaining to aspects of personality are placed in one of three categories; *True*, *False*, or *Cannot Say*. Answers are then evaluated in terms of psychiatric categories.

- Minnesota Paper Formboard** A test of mechanical aptitude which requires the subject to tell which bits go together to make up each of a series of patterns.
- mob** A large number of people showing great excitement and bent on some antisocial act, such as looting or lynching. Not always distinguished from *crowd* which, however, is not necessarily so highly excited and anti-social.
- mode** In statistics, the most frequent score of a series.
- monetary incentive** The inducement to work for money as a reward.
- mongolian** Feeble-minded person resembling a mongoloid.
- monochromatic light** Light that is relatively pure, approximating a single wave length, e.g., a pure red.
- monocular cues** Those obtainable with one eye, as distinguished from binocular cues.
- monomaniac** Mentally deranged person with a fixed idea or a "one track mind."
- morale** Signified by individual or group perseverance in performance of the work at hand. Also a cheerful, or confident, or satisfied attitude.
- mores** The group ways, social customs.
- moron** The highest grade of feeble-mindedness, represented by an I.Q. ranging from 50 to 70.
- motivation** The inner control of behavior as represented by physiological conditions, interests, attitudes, and aspirations.
- motive** An impulsion or urge to attain some goal-object (like food when hungry) or some goal (such as being an engineer). Similar to *drive* except that, in the case of a drive as such, there is no clearly defined incentive.
- motor area** The region of the cerebral cortex, which controls voluntary motor activity.
- motor neuron** Nerve cell and fiber (efferent) which carries impulses to the motor organs (muscles and glands).
- motor set** A muscular readiness to respond.
- motor speech area** Region, in the left frontal lobe, which controls speech. Destruction of this area is followed by motor aphasia. Otherwise known as Broca's area.
- Müller-Lyer illusion** A line of a given actual length is made to appear longer or shorter by the addition of lines such as enclosing arrowheads or arrowheads extending outward from its end.
- multiple-choice problem** The subject is confronted with doors, keys, or other objects which, at each setting, differ in number and position. He selects one in each setting and, if this is correct, it is related to the others in terms of some principle, such as the middlemost, the second from the right end, and so on.
- multiple-choice test** Any test in which statements or questions are given, each followed by two or more alternatives from which the subject must select the most appropriate. Thus: Psychology is the scientific study of: (1) organisms, (2) behavior, (3) the soul.
- multiple personality** The same person expresses several personalities. Two personalities (*dual personality*) is exemplified by Dr. Jekyll and Mr. Hyde. Some people have been known to express as many as four personalities.
- muscle tensions** Tightening of muscles; or a shift in muscle tonus.
- myelin sheath** The fatty covering of some nerve fibers. Also called a *medullary sheath*.
- natural selection theory** The idea (Darwin's) that variation naturally occurs in structure and behavior and that, in the struggle for existence, those having the most adaptive characteristics will survive and reproduce their kind.
- naturalistic observation** Observation in the field without manipulation of the situation by the experimenter.
- needs** Requirements for optimal adjustment to the environment, like the need for food, water, and so on.
- negative conditioning** Conditioning in which the individual learns not to make an accustomed response.
- negative correlation** Correlation of less than zero, as when one series of paired measurements decreases while the other increases.
- negative reinforcement** Punishment or reproof, especially in relation to learning.
- negative transfer** Habit interference, as when

- learning one skill makes it harder to learn another.
- nerve** A bundle of nerve fibers.
- nerve fiber** Threadlike structure, extending from the cell body of a neuron, which transmits the nerve impulse.
- nerve impulse** A successive release of energy along a nerve fiber.
- nerve net** A network of nerve fibers in which there are no synapses and the impulse thus goes indiscriminately through all fibers.
- nervous breakdown** A blanket term referring to the onset of a neurosis or psychosis.
- nervous system** General term referring to all neural structures and mechanisms.
- neural circuits** The courses followed by nerve impulses in transversing various parts of the nervous system.
- neural trace** See *engram*. Also referred to as a *neurogram*.
- neurasthenia** A functional behavior disorder characterized by abnormal fatigue and bodily complaints. Means literally, a *nerve weakness*. One of the neuroses.
- neuran** A nerve cell and its fibers.
- neurosis** A functional behavior disorder which, while troublesome, is seldom sufficiently severe to require institutionalization. Also referred to as a *psychoneurosis*.
- neurotic** Pertaining to neurosis. Sometimes used to designate a person who has a neurosis. Also, as in *neurotic behavior*, behavior involving the symptoms found in a neurosis.
- night blindness** Unusually poor visual sensitivity under low illumination, a result of slow or absent dark adaptation.
- noise** Auditory result of aperiodic vibrations. This term is also used in information theory and related areas to represent anything which interferes with transmission of a message (distortion in the communication channel) as well as any diverting or confusing element in what is received. An ambiguous message involves noise in this sense. In a categorization experiment where, say, the elements of importance to the development of a concept are size and brightness, the irrelevant inclusion of hue would lead to the designation of hue as a "noisy attribute."
- nonauditory labyrinth** The semicircular canals and vestibule.
- nondirective therapy** Otherwise known as "client-centered." It is characterized by relatively little direction or suggestion from the therapist. Insight as to the nature of the problem and its solution is not given directly by the therapist but must come from the client himself.
- nonsense syllables** Three or more letters which do not make sense, which have little or no meaning for the subject.
- nonspecific projection system** This is made up of collaterals from the ascending nerve paths. Whereas the specific projection fibers from these paths go on to the thalamus and then synapse with fibers going to the so-called "projection areas" of the cerebral cortex, the fibers of the nonspecific system enter the reticular formation, activating it and alerting the organism. See *ascending paths*, *reticular formation*, and *thalamus*.
- nonstructured** Subject to various interpretations, like ink blots. *Structured situations* tend to produce stereotyped outcomes.
- nonverbal communication** Communication without words — by gestures, pictures, the wearing of certain uniforms, and so on.
- nor-adrenalin** A secretion of the adrenal medulla (along with adrenalin) and apparently also of nerve-endings in the sympathetic nervous system. According to Hall (*The Functions of the Endocrine Glands*, Saunders, 1959) this recently discovered hormone is particularly involved in the maintenance of normal blood-pressure levels.
- norm** Having reference to normal in terms of average.
- normal** Approximating the average.
- normal personality** Conceived statistically, as the average or the most usual. Generally speaking it is characterized by pursuit of worth-while goals and the enjoyment of life.
- normal probability curve** The so-called "chance curve" which is symmetrical (more or less bell-shaped) with most of the measurements bunching up near the middle and the rest tapering off to the two extremes.

**normative study** One which establishes norms such, for example, as the average or median age at which children stand alone, walk, say their first word, and so on.

**nurturance** Parental attention or control.

**nymphomania** Unusually strong sexual desires in a woman.

**objective approach** One that is social, in that all can confirm the observation for themselves; contrasted with subjective.

**objective tests** Those scored with a prescribed key — may be machine scored.

**observational learning** Learning by looking a situation over and figuring it out. See *insight*.

**observer** Term used by experimental introspectionists to represent the person who observes and reports on his own experiences — the person who introspects under these circumstances. Now largely replaced by the term *subject*, which has no introspective connotations.

**obstruction method** Testing the persistence of motivated behavior under conditions where, in order to reach the incentive, the organism must submit to an electric shock or some other impediment.

**occipital lobe** That at the back of each cerebral hemisphere which is concerned primarily with vision and related perceptual and associative functions.

**occupational therapy** Attempting to alleviate mental illness or other disorders by having the individual engage in interesting work — use of work for its remedial effects.

**Oedipus complex** A Freudian term to represent the sexual attachment of a son for his mother. This is regarded as usually repressed and disguised in various ways. Going with this complex, according to Freud, is jealousy of the father because he can have intimacies with the mother that the son is denied. Also see *Electra complex* and *complex*.

**old brain** The part which preceded the cerebral cortex in evolution.

**olfaction** The sense of smell.

**olfactorium** An odor-free enclosure used for studying olfactory sensitivity much as a dark room is used to study visual sensitivity.

**olfactory bulbs** The two small bulblike structures below the frontal lobes and immediately above the olfactory epithelium. They give rise to the nerve fibers which mediate olfactory sensitivity.

**olfactory epithelium** Cells in the upper ends of the nostrils which contain the receptors for smell.

**onomatopoeic words** Those which sound like the object represented, such as bow-wow for dog. According to those who hold an onomatopoeic theory of linguistic origins, our primitive ancestors imitated the sounds of natural phenomena and used these imitations as symbols representing the phenomena in question.

**ontogenetic study** That dealing with development in the individual organism. Compare *phylogenetic*.

**operant** Any response that is instrumental in producing certain consequences — like a food reward or an electric shock. It, so to speak, “operates” on the environment.

**operant conditioning** A type of instrumental conditioning which involves the modification of an operant. A response which the organism emits is reinforced in certain ways, in accordance with certain schedules, and resulting changes in its rate of occurrence are studied. The rat’s pressing a lever and the pigeon’s pecking a disc are operants widely used in studies of operant conditioning. The reinforcement is usually food, although a secondary reinforcer (say a click previously associated with food) may be used.

**optic chiasma** The partial crossing of optic nerve fibers.

**optic nerve** The tract carrying all nerve impulses from the eye to the brain stem.

**optic radiation** The system of fibers projecting visual impulses into the occipital lobe.

**oral** Referring to the mouth.

**oral eroticism** Pleasure derived from stimulation of the mouth, as in sucking.

**ordinal scale** One which deals with the relative position of individuals (rank order) with respect to some characteristic, such as first, second, third, fourth. Contrasted with scales involving physical units (ratio scales). See *ratio scale*.

**ordinate** The vertical (or *y*) axis of a graph.

**organ of Corti** Structure on the basilar mem-



- brane of the inner ear where energy of sound waves stimulates receptors and initiates nerve impulses.
- organic** Having to do with the organism, with structure as opposed to function.
- organic sensitivity** Sensitivity of organs within the body cavity, like the viscera.
- organism** The entire living creature.
- ossicles** The three small bones in the middle ear which amplify and convey sound vibrations to the inner ear.
- otoliths** Small grains in the labyrinth of the ear which play a role in perception of movement and maintenance of equilibrium.
- outgroup** The group to which one does not belong. Compare with *ingroup*.
- oval window** Membranous opening of the cochlea against which the ossicle known as the "stirrup" vibrates.
- overcompensation** More than balancing a deficiency.
- overlapping distributions** Those falling partly within the same range.
- overlearning** Learning more than is necessary for one correct performance.
- overt behavior** Observable by others. Social rather than private. Compare with *implicit (covert)*.
- Pacian corpuscles** Specialized end organs in the skin which are responsive to heavy pressure.
- paired associates** Words, syllables, digits, or other items learned in pairs so that, when one is given, its associate is recalled.
- pancreas** A large gland, situated near the stomach, which secretes gastric juices and also contains the islands of Langerhans, which secrete insulin. See *insulin*. Only the latter is an endocrine secretion (hormone).
- paralysis** Loss of ability to move some part of the body.
- paranoid** Pertaining to a type of mental illness in which the person has delusions, especially of reference, such as imagining that people are doing things to him or saying things about him.
- parasympathetic nervous system** The part of the autonomic system which functions in opposite relation to the sympathetic system.
- paresis** General paralysis of the insane, an organic psychosis usually originating in syphilitic infection.
- parietal lobe** That situated between the fissure of Rolando and the occipital lobe. It plays a special role in somesthetic sensitivity.
- partist strategy** A procedure (in experiments on concept formation) which bases inferences on part of the situation rather than the situation as a whole (upon all possible available cues). Compare *wholist strategy*.
- passive learning** Learning without the intention to learn, incidental learning. Also see *latent learning*.
- pecking order** See *dominance hierarchy*.
- pencil-and-paper tests** Those requiring written answers and usually scored with a key.
- perceiving** Discriminating, differentiating, observing, grasping the meaning of things.
- percentile** The rank position of an individual in a serial array of data stated in terms of what percentage of the group he equals or exceeds.
- perception** The process of perceiving.
- perceptual constancy** The tendency of aspects of our world to be perceived as constant (in brightness, color, size, etc.) despite a certain degree of change in their stimulus characteristics.
- perceptual-motor habit** Any skill involving overt reactions based upon perceptual cues. See *sensorimotor*.
- performance tests** Those requiring little or no verbal instruction or verbal response by the subject.
- periodic vibration** The oscillations come in definite cycles and give rise to tonal experiences, as distinguished from aperiodic vibrations, which give rise to noise.
- peripheral adjustments** Those of the sense organs and muscles.
- peripheral-central theory** Concept of thinking which supposes that it involves an interplay between peripheral (sensory and motor processes) and central (i.e., brain) processes.
- peripheral nervous system** The spinal and cranial nerves, including the autonomic system. The nervous system which connects

- the brain and spinal cord with the receptors and effectors.
- peripheral retina** That outside of the foveal region.
- peripheral vision** In the periphery, out of the "corner of the eye."
- permissive attitude** One which avoids direct or implied criticism of what another says or does. The attitude ideally assumed by a psychological counselor in listening to his client's recounting of experiences, even those which might bring censure from parents, teachers, or others in an authoritarian position. This does not mean, however, that the counselor approves of the conduct in question.
- perseveration** The continuance of a process after the stimulus has been removed, like the running of a tune through the head.
- persona** The mask worn by an actor in ancient times to indicate his role — possible origin of the term "personality."
- personal equation** A term used in the early days of reaction-time studies to represent a difference in the rapidity of response of equally competent observers, as when astronomers differed in their reporting of the exact moment a star crossed a line as viewed in the telescope. See *reaction time*.
- personal motives** Those which originate in unique individual experience as contrasted with those that are inborn (the physiological) and those common to members of a particular culture (the coenotropes).
- personal-social motives** Those that are individual (rather than universal or widely prevalent) yet, in their origin and expression, dependent upon cultural and other social influences.
- personality** The most characteristic integration of an individual's structures, modes of behavior, interests, attitudes, capacities, abilities, and aptitudes — the whole person as others see him.
- personality profile** A graph which shows the scores (or percentiles) made by the individual on a series of personality tests or inventories.
- perversion** Acts that are unnatural, not acceptable to the group.
- phase** In *audition*, two or more sound waves are said to be in phase if they go through the same cyclical fluctuation in unison, as, for example, when their crests or troughs coincide.
- phenomena** Any observable objects or events.
- A phenomenon**, as used in psychology, means no more than something observable.
- phenomenology** Systematic study of immediate experience, or of the world as it appears to the observer. Contrasted with an analytic approach like that of Wundt and his followers.
- phenylpyruvic feeble-mindedness** An enzyme necessary for the oxidizing of a substance in protein known as **phenylalanine** is missing. Consequently, phenylpyruvic acid accumulates in the tissues and interferes with normal functioning of the brain.
- philosophy** General discipline concerned with the ultimate nature of the world and of man.
- phi-phenomenon** Apparent movement, as in motion pictures and certain electric signs.
- phobias** Apparently unreasonable fears, as when one fears a mouse, fears that he may be buried alive, or fears to stand on a high place.
- phonemes** The distinguishable vocalizations out of which speech develops — the separate vowel sounds are phonemes and also the separate sounds in consonants. The sounds which make up the International Phonetic Alphabet.
- photochemical reaction** One involving chemical reactions initiated by light, as in a photographic film and in the retina.
- phrenology** The attempt to discern character and other aspects of personality from "bumps" on the cranium.
- phylogenetic psychology** That which studies development of psychological processes in organisms ranging from the lowest to the highest. It is thus concerned with psychological evolution. Compare with *ontogenetic psychology*.
- physiognomy** The attempt to discern personality traits, including character and aptitudes, from such facial conformations as the shape of the nose and the set of the jaw.
- physiological cues** Those, in space perception, which come from biological makeup, like

- the distance between the eyes and accommodation of the lens.
- physiological drives** Impulsions which stem from the biological needs of the organism, like the need for food and for sleep.
- physiological limit** This, with reference to learning, is the maximum proficiency attainable in view of the individual's makeup (the maximum speed at which he can work) and the nature of the situation (the maximum number of correct responses possible).
- physiological needs** Those determined by our biological makeup.
- pitch** The qualitative aspect of sounds in terms of which they may be described as high or low.
- pituitary gland** A structure at the lower end of the hypothalamus which has extremely important endocrine functions. Secretions from the posterior lobe of this gland have certain metabolic functions which are as yet far from clear. Its anterior lobe secretes hormones which play a role in sexual and general bodily development (giving rise to dwarfism if insufficient and to gigantism if excessive). The anterior lobe also secretes hormones which play a key role in metabolic processes. Among these is ACTH. Prolactin, important in motivating maternal behavior in animals, is likewise secreted by the anterior pituitary. The pituitary is generally regarded as the pacemaker of the whole endocrine system.
- place learning** Learning a place — i.e., where food is located, where to escape. Compare *response learning*.
- place theory of pitch** The theory that the pitch of a sound is determined by the place in the basilar membrane maximally activated by a sound wave of a particular frequency.
- placebo** Literally, something to please. A pill of no medicinal value given to a patient to please him, to make him think that he is taking medicine. Used in drug experiments to prevent subjects from knowing whether or not they have been given the drug. They all think that they are taking it, because the pills or capsules look alike, but the control subjects are getting the placebo.
- plateau** A period of little or no progress followed by further learning.
- play therapy** Play designed to help the patient (usually a child) release tensions or learn adequate adjustments to the situations which disturb him.
- pleasantness** A feeling associated with reduced tension; objectively manifested by a tendency to seek further contact with the instigating objects or situations.
- pleasure principle** The tendency of organisms to seek satisfaction of their urges.
- plethysmograph** Instrument with which changes in blood supply to a part of the body, like a limb, are recorded.
- pneumograph** Instrument placed around the chest, and sometimes the waist, to record respiratory changes.
- polarized light** Light passed through some medium which makes it vibrate in only one direction, say vertically or horizontally.
- polydactyly** Having more than five fingers.
- polygraph** Apparatus for recording several responses concurrently, as in a lie detector where changes in respiration, blood pressure, and the G.S.R. are recorded on a moving tape.
- positive correlation** Changes in one variable are concomitant with and in the same direction as those in the other, as, for example, in the relation between the level of intelligence and school grades.
- post-hypnotic suggestion** After being awakened, the subject follows suggestions given during hypnosis.
- postnatal** After birth.
- postural changes** With reference to emotion; gross changes in bodily attitudes, like crouching, running, and striking.
- postural set** An overall motor readiness to respond, as in the case of a runner on the mark.
- practice** As distinguished from training, a more or less blind trial-and-error attack on a learning problem.
- precocity** Development far in advance of that usually found at a given age.
- preconscious** Anything which may readily become conscious is said to be in the preconscious. Thus I may become aware of some obligation at this moment of which I was oblivious a few moments ago. Dia-

- grammatically pictured by the Freudians as a region between the conscious and the unconscious.
- predisposition** Being already set (in terms of heredity or learning) to react in a certain way. See **set**.
- prejudice** Pre-judgment, an attitude or opinion prior to or independent of an examination of the facts in the case.
- prenatal** Prior to birth.
- preporotion stage** In creative thinking, gathering, and attempting to integrate, relevant information.
- perceptive set** Attending, as in looking or listening.
- prestige** High reputation, great influence, glamour.
- primary mental abilities** The abilities disclosed by factor analysis to be the basic components of intelligence. There are differences of opinion as to the number and nature of primary abilities.
- primary needs** Those that are basic, like the need for food, water, warmth, and so on. Needs that are inborn, dependent upon the inherited makeup of the organism. Compare with **secondary needs**. Also see **drive**.
- primary reinforcement** Satisfaction of physiological needs (or drives) like the need for food and sleep. See **primary needs**.
- primitive organization** A patterning of perception prior to, or independent of, learning.
- principles, in transfer.** Formulations of the nature of a problem which then aid in the solution of other problems involving the same or similar principles.
- private information** Subjective, that which only the experiencing individual can observe. See **introspection**.
- private attitude** One not overtly expressed, but sometimes indirectly revealed by use of projective procedures. See **projective methods**.
- proactive inhibition** A type of negative transfer observed in memory experiments and other learning situations. It occurs when an item preceding that to be learned interferes with learning of the latter, or its subsequent recall. Compare with **retroactive inhibition**. Also see **negative transfer**.
- probability curve.** See **normal probability curve**.
- problem box** One with latches, strings, or other devices which the subject must manipulate in an appropriate way in order to get in, or out.
- problem solving** Adjusting to a situation by acquiring new modes of response. The term is used especially to represent learning in which a certain amount of insight or reasoning may be displayed, as in learning a problem box or finding the solution to a verbal problem.
- product-moment correlation** Procedure which yields the coefficient of correlation, or  $r$ .
- profile** A graph which represents the variation, within the individual, from one type of performance to another as, for example, his relative rank in each of several skills or on each of several personality tests.
- projecting** The act of perceiving one's own characteristics in another or, in fantasy, interpreting situations as though one is part of them and that they reflect one's own situation, problems of adjustment, and so on. Also see **projection**.
- projection** Attributing one's own motives or thoughts to others as when a cheat supposes that others cheat or that the evil which he knows exists in himself is discerned by others.
- projection areas of cerebral cortex** Those to which sensory impulses are "projected" from the thalamus and from which motor impulses are sent downwards.
- projection paths** Those carrying nerve impulses up the spinal cord to the thalamus and subsequently to the projection areas of the cerebral cortex. See above.
- projective methods** Those which require the subject to interpret situations susceptible to many different interpretations, or to different perceptual organizations. The person's interpretation (of ink blots, pictures, etc.) is then taken as a projection of his personality structure.
- prolactin** Hormone from the anterior pituitary gland which stimulates milk secretion and contributes in other ways to maternal behavior.
- proprioception** The type of sensitivity mediated by receptors (proprioceptors) in those organs which, through their own activity, stimulate themselves. The two proprioceptive senses are the static and

- kinesthetic.** Proprioception is one important basis for feedback within the organism. See **kinesthesia**, **static sense**, and **feedback**.
- protective reflex** Withdrawal in response to painful stimulation.
- pseudo-affective** Merely simulating reactions indicative of feeling or emotion. Sham emotion.
- pseudophone** Instrument with which sound stimulation of the ears is reversed, sounds normally going to the left ear now going to the right, and vice versa.
- pseudopsychology** False or fictitious psychology, psychological quackery.
- psyche** Ancient Greek word for the soul or what, today, we call the mind.
- psychiatrist** A medical doctor who specializes in mental (or behavior) disorders.
- psychiatry** Branch of medicine concerned with mental (behavior) disorders.
- psychoanalysis** A psychotherapy which typically involves reverie and the analysis of dreams. The patient's difficulties are interpreted for him by the analyst and he is advised what to do to alleviate them. The data made available through psychoanalytic procedure are usually interpreted in accordance with psychoanalytic theory. The original theory, that of Freud, placed great emphasis upon repressed (subconscious) sexuality. There are now several schools of psychoanalysis, some of which differ from Freud's in placing considerably less emphasis upon sexual motivation. Some of these emphasize the social as well as the biological bases of human motivation.
- psychoanalyst** One who is qualified to use psychoanalytical procedures in dealing with behavior disorders.
- psychodrama** Having mental patients act out (dramatize) situations relevant to their difficulties.
- psychogalvanic response** A change in electrical resistance in the skin which results, among other things, from sweat gland activity elicited by emotion-provoking stimuli. Otherwise referred to as the galvanic skin reflex (GSR) or the electrodermal response. One of the responses involved in lie detection.
- psychogalvanometer** Device for recording the psychogalvanic response.
- psychograph** Another name for a psychological profile. It is a graph which represents the degree to which various traits differ within the individual.
- psychological clinic** A place to which people come for help with psychological problems.
- psychological cues** In space perception, those which depend for their interpretation upon previous experience in comparable situations.
- psychological environment** That to which the person responds in terms of its meaning for him.
- psychology** The science of behavior, or of the adjustments of organisms to their environment. The study of mental life in its most inclusive sense.
- psychomotor tests** Those which, while based upon other psychological processes (sensory, perceptual), call for a motor reaction such as pressing a key, holding a stylus as steady as possible, or manipulating controls.
- psychoneurosis** One of the milder behavior disorders otherwise known as a *neurosis*. See *neurosis*.
- psychopathic personality** A character disorder. The individual with this type of disorder, referred to as a *psychopath*, is defective in that he fails to observe the rules which govern conduct in his society. He has failed to develop a normal superego. He may steal, lie, murder, and commit other offenses without the qualms of conscience which other people would have under such circumstances. See *superego* and *conscience*.
- psychophysical methods** Those used in psychophysics as defined below.
- psychophysics** Quantitative measurement of the relation between experienced aspects of stimulation (brightness, loudness, etc.) and the characteristics of the stimulus, usually its intensity.
- psychosis** The most serious type of mental disorder. It is known, legally, as *insanity* and it usually requires treatment in a mental hospital. The person is said to be *psychotic*.
- psychosomatic medicine** That branch con-

- cerned with physical disorders (like some allergies, high blood pressure, and ulcers) which originate in, or are aggravated by, emotional difficulties.
- psychosurgery** Brain surgery carried out to alleviate mental illness, as in the case of prefrontal lobotomy.
- psychotherapy** Any procedure designed to alleviate behavior disorders (mental illness, adjustment problems) by psychological means — suggestion, psychoanalysis, counseling interviews, play therapy, and so on.
- psychotic** Deriving from a psychosis; the person who has a psychosis; an idea like the illogical (or insane) conclusion that people are putting ground glass in the food, or that the patient is God.
- puberty** The time at which menstruation begins in girls and seminal emission in boys. The onset of adolescence.
- puberty praecox** Puberty at an unusually early age.
- pugnacity** Wanting to fight, quarrelsomeness, aggressiveness intended to injure others.
- punishment** Any form of stimulation imposed upon the individual which he finds distasteful, or which he normally tries to avoid.
- pupil** Opening in the iris through which light enters the eye.
- pupillary response** Contraction or dilation of the pupil, as when light strikes the eye or is withdrawn.
- pyknic physique** Rotund, endomorphic body build.
- qualitative** Having to do with the estimation of qualities — like good, reliable, dishonest. Contrasted with measurement that is quantitative. See **quantitative**.
- quality** A term sometimes used to represent the most distinguishable aspects of experience — sour, blue, middle C, and so on. These are called “qualitative” aspects of experience or merely “qualities.” This contrasts them with the intensive or “quantitative” aspects, such as the sourness of what is sour, the brightness of blue, the loudness of middle C.
- quantify** To deal with something in terms of measurable quantities, such as amount, extent, duration.
- quantitative** Having to do with measurable quantities. Psychophysics is quantitative in that it deals with measurable stimuli and measurable responses. Compare **qualitative**.
- quantitative ability** Ability to deal with numbers as in solving mathematical problems. Distinguished, in some tests, from so-called *verbal ability*, where there is facility with words and related concepts.
- r** The coefficient of correlation.
- racial history** The history of one’s race. As we have used the term, our human inheritance and its evolution.
- radiant energy** That transmitted by radiation, such as in light and heat.
- rage** An intense degree of anger, often giving rise to aggressive behavior.
- range** The difference between the highest and lowest scores in a series.
- range of hearing** The number of double vibrations between the lowest (about 20 in man) and the highest (about 20,000) that can be heard. Roughly 20,000 cycles in man.
- rank difference correlation (Rho)** Correlation between two series of paired measurements each ranked according to magnitude.
- rate of manipulation test** One in which the individual turns over small circular blocks as quickly as possible and in a particular sequence.
- rate of response** Its frequency (how often it occurs) per unit of time. Studies of operant conditioning are especially concerned with changes in response rate.
- rating** Representing the degree to which some trait is present as judged from observation, like judging whether a child’s play is very constructive, moderately constructive, or lacking in constructiveness.
- ratio scale** One that uses physical units, so that we can say, for example, that one person is two times as quick as another, only one-half as strong, or one-tenth heavier. Compare **interval scale** and **ordinal scale**.
- rational elaboration of ideas** Evaluating infer-

- ences mentally before accepting or rejecting them.
- rationalizing** Finding what are apparently good reasons for actions. Making what is irrational appear to be rational. Excusing one's actions on irrational grounds. See also *sour grapes reaction*.
- reaction** Any movement resulting from stimulation.
- reaction mechanisms** The structures of the body (sensory, neural, and motor) which underlie response to the environment.
- reaction time** Speed of reaction.
- reality principle** The demands of the id (pleasure principle) are adapted to actualities in the physical and social environment.
- reality testing** A term used by Freud to refer to the exploratory or probing behavior which informs the individual of the consequences of commerce with the environment. Basic to development of the ego.
- reasoning** Solving some problem implicitly, using symbols to represent objects or situations. Thinking one's way through the problem rather than making an overt attack upon it.
- recall** Revival of past experience.
- recapitulation theory** The theory that each individual, during his early development, recapitulates (repeats) certain stages through which his race passed in its evolution from lower forms of animal life. The human embryo, for example, has gill slits at one stage and a tail at another. It has also been claimed, without adequate foundation, that the monkey-like antics of young children are attributable to the fact that human beings passed through an ape-like period in their evolution.
- receptor** Specialized end organ which receives stimulation. The receptors of the eye, for example, are the rods and cones.
- receptor-effector system** The system which connects receptors and effectors, which of course includes the central nervous system.
- receptor set** The readiness of a sense organ, like the eye or ear, to receive stimulation, as in turning the head or eyes in a particular direction to see or hear something.
- recessive gene** One which plays a noticeable part in the development of an organism only when paired with one like itself (i.e., not dominant).
- recitation** As a learning procedure: trying to recall what one is memorizing, as opposed to merely reading it repeatedly.
- recognition** Perceiving something as having been experienced before, as being familiar.
- rectilinear** In a straight line.
- redintegration** Recalling a whole experience, or making an appropriate reaction, in terms of some fraction of the original circumstances.
- reduced cues** Weaker, or less evident, or only a fraction of former stimulating circumstances. Minimal cues.
- redundancy** In ordinary usage, this means more words than are necessary to convey a message (mere verbiage). Information theorists, however, use it in a somewhat different sense. For them, *u* after *q* is redundant in English because it is almost certain that, given *q*, the next letter will be *u*. Likewise, *yours* after *sincerely* is redundant because, with *sincerely* given, *yours* adds nothing to the message.
- re-education** The recovery of lost functions through special training; replacement of inadequate modes of adjustment with newly acquired habits.
- reflectance** The property, possessed in different degrees by various surfaces, of throwing light waves back (reflecting instead of absorbing them). See *absorption curve*.
- reflex** An initially unlearned response of a particular part of the body, like the knee jerk to a blow on the patellar tendon, or the contraction of the pupil in response to light.
- reflex arc** The essential neural mechanism involved in a reflex, i.e., the sensory, motor, and association neurons which provide a link between the stimulus and the response.
- reflex circle** A type of feedback which occurs when contraction of a muscle, through stimulation of kinesthetic receptors in that muscle, provides stimulation for a further contraction. Believed to play a part in babbling and the grasping reflex.
- refractory period** That (immediately following stimulation) during which a neuron is in-

- capable of further excitation. This is the *absolute* refractory period. The *relative* refractory period is that, after the absolute, during which only a stronger than normal stimulus can excite the neuron.
- regression** Going back to an earlier, and usually less adequate, mode of response.
- reinforcement** Reduction (or satisfaction) of a drive; reward; used by Pavlov to refer to the following of the conditioned by the unconditioned stimulus, as in the case of food coming after the bell. See *negative reinforcement*, *primary reinforcement*, *secondary reinforcement*, *verbal reinforcement*, and *schedules of reinforcement*.
- Reissner's membrane** Wall between the vestibular and the cochlear canal of the inner ear.
- relative movement**, in distance perception. Objects that move rapidly in the opposite direction are judged to be nearer than those which move more slowly, or seem to move with the observer.
- relearning** Attempting to regain a skill that has been partially or wholly lost. The savings involved in relearning, as compared with original learning, give an index of the degree of retention.
- reliability of tests** Their dependability as measuring instruments. This is indicated, among other things, by a high correlation between scores on a test and on a retest of the same individuals.
- reliability coefficient** An index of the consistency with which a test measures. Often based upon the correlation between scores obtained on the initial test and a retest (test-retest reliability). Also obtained to discover the consistency of ratings, as between two or more observers. See *reliability of tests*.
- reminiscence** Improved recall of incompletely learned material after an interval, as when the subject recalls 80 per cent of a list of words at the end of practice and 85 per cent after a short interval.
- repression** Putting unpleasant things "out of mind" or into "the unconscious."
- reproducing** Performing something that one has learned, like a trick, a poem, or a picture that is redrawn.
- reproof** As a factor in learning. Scolding or criticism.
- research** Critical investigation as in the pursuit of knowledge. The basic method used in the increase of scientific-knowledge or scientific understanding.
- respiratory changes** Those involved in breathing.
- response** An action such as doing or saying something, commonly involving the action of a muscle or a gland.
- response learning** Learning to make certain movements as such, contrasted with learning to find a certain place, or follow a certain principle.
- response-response (R-R) laws** Those dealing with the correlation of one type of activity with another — for example, responses on a test (test score) and performance on the job (perhaps as rated by a supervisor).
- retardation** Unusually slow or stunted psychological development.
- retention** Holding onto what has been learned so that it can be utilized later, as in recall; or, if retention is partial, in relearning.
- reticular formation** A network of intricately interconnected nerve-cell groupings which runs through the center of the brain stem from the level of the medulla to the lower part of the thalamus. It receives impulses through collaterals of the projection pathways (nonspecific projection system) and also from the upper brain structures, including the cerebral cortex. Its main function appears to be that of alerting the cerebral cortex in readiness for incoming information. Its lower part has an inhibitory influence on certain motor activities. See *nonspecific projection system*.
- retina** The innermost coat of the eye which contains the rods and cones and is thus photosensitive.
- retinal color zones** The regions of the retina which respond to particular colors, like the center to red and green and the more remote region to yellow and blue.
- retinal disparity** Slight difference between retinal images of an object viewed with, respectively, the right and the left eye.
- retinal image** The picture projected onto the retina by light rays; analogous with the picture projected on a photographic film.
- retrograde amnesia** Forgetting of things ac-



- tually known before the amnesia-producing event, like forgetting the identity of the opposing player in a football game who was responsible for the blow that produced the unconsciousness. See **omnesia** and compare **anterograde amnesia**.
- retroactive inhibition** The partial or complete obliteration of what has been learned which results from some more recent event — like an emotional shock or new learning.
- reverberating circuits** Feedback mechanisms within the nervous system, as when a nerve impulse, once started, traverses the same circuit repeatedly.
- reverie** A dreamlike state in which one lets his thoughts wander; a form of free association. Differentiated from daydreaming in that the associations have no recognized goal.
- revolving drum** Device which records an animal's running activity in terms of revolutions of the drum.
- reward training** Reinforcing a response (operant) so that it occurs more frequently. See **operant conditioning**.
- rewards** Incentives, positive reinforcements. See also **drive reduction**.
- reversible configuration** A picture perceived now as one thing, then as another, as in the case of the picture seen both as a vase and as two facing profiles.
- rho ( $\rho$ )** The coefficient of rank difference correlation.
- rivoly** Competition between individuals, or groups, or processes. See **retinal rivoly**.
- rods** Rod-like retinal structures containing visual purple and serving to mediate achromatic vision.
- role** The part played or the function performed by a person in a particular group situation, like the role of teacher, president, secretary.
- role playing** The acting out of certain roles in simulated situations, as when a person being trained for a foreman's role in industry acts the part of foreman with others playing the part of workers.
- Rorschach test** A series of inkblots used as a projective personality test.
- round window** Round, membrane-covered, separation of the middle ear from the tympanic canal of the cochlea; located just below the oval window.
- Ruffinian cylinders** Structures in the skin which were once thought to mediate sensitivity to warmth but whose actual function is unknown.
- rumor** Any unverified report or account of an event that circulates freely by word of mouth.
- sacculle** A small sac-like structure making up part of the vestibule of the non-auditory labyrinth.
- sodist** One who gets pleasure out of hurting others.
- salivary response** Secretion of saliva by the parotid and other glands of the mouth.
- saturation, color** The degree to which color of a given hue is present, i.e., different from gray of the same brightness level. A highly saturated red, for example, is very red and a poorly saturated red only barely distinguishable from gray.
- sotyrasis** Exceptionally strong sex drive in men.
- sovinings method** Estimating the degree of retention in terms of the reduction in time or trials to relearn as compared with those required in original learning.
- scapegoating** The process of finding a person or group (scapegoat) on which to blame some real or imaginary wrong. Finding a substitute object for one's aggressive tendencies, as when the man who is angry with his wife "takes it out" on his children, or employees. Also see **displacement**.
- scattergram** A graph which illustrates the extent to which two series of paired measurements are correlated.
- science** The systematic, impersonal, search for verifiable knowledge.
- scientific method** That which has the characteristics cited for science.
- schedule of reinforcement** Scheme in accordance with which an operant will be reinforced. Thus, in a lever-pressing situation, every displacement of the lever may bring a pellet of food (*continuous schedule*); the pellet may come every five seconds, regardless of how many displacements occur earlier (*fixed interval schedule*);

- the pellet may come at every tenth displacement (*fixed ratio schedule*); or the pellet may come in accordance with a varying interval or varying ratio (*variable interval* or *variable ratio schedule*). See **reinforcement**.
- schizophrenia** Literally, a splitting of the mind, or of personality. A form of mental illness characterized by extreme withdrawal from reality. Since it involves marked mental deterioration (dementia) and often appears relatively early in life (adolescence or early adulthood) it has also been given the name *dementia praecox*.
- sclerotic coat** The outermost covering of the eyeball.
- secondary needs** Those not related to physiological makeup; for example, the need for an auto, a fashionable dress, etc.
- secondary reinforcement** Reinforcement through something which, while it does not satisfy a need directly, has been associated with such satisfaction. Thus a sound associated with food (primary reinforcement) may come to have reward value in itself — to serve as a secondary reinforcer.
- secondary sex characters** Aspects of the body which differentiate the sexes but which have no direct sexual functions, such as body build, voice, distribution of hair.
- second-order conditioning** The use of a conditioned stimulus as the basis for further conditioning, i.e., as secondary reinforcement.
- seizures** Spasms or convulsions of all or part of the body.
- self** The individual (the I) as represented in his own awareness, and in the setting of those things with which he identifies. The ego and its involvements.
- self-assertion** The motive to dominate, to master, or to stand out in comparison with others.
- self-consciousness** Awareness of self, especially in social relations, where such awareness may have embarrassing effects.
- self-excitation** Stimulation of an organ by its own activity, as in the case of muscular contractions producing stimuli which cause the muscle to contract again. See also *reverberating circuits* and *feedback*.
- self-repudiation** Disparagement of the individual by himself.
- selves** Actions at different times suggest that different personality integrations exist within the same individual, as in the dual selves (or personalities) of Dr. Jekyll and Mr. Hyde. The normal person, since he reacts differently in different situations, is sometimes said to have a "social self," a "religious self," a "fraternity self," and so on.
- semantics** The study of word meanings.
- semantic differential** An index used in an attempt to quantify word meanings. It is based upon the rating of words in terms of such dimensions as good-bad, active-passive, and so on. What one gets, finally, is a profile which represents a word's rating on each dimension. Profiles for different words can then be compared.
- semicircular canals** The three canals of the inner ear which mediate sensitivity to rotation.
- senescence** Old age. The aged are referred to as *senescent*.
- senile psychosis** A mental illness associated with, but not a necessary concomitant of, old age. It may take many forms, including mania and depression.
- sensation** Theoretically an irreducible sensory experience such as might exist the first time a particular receptor is stimulated — i.e., a receptor process as such, devoid of meaning.
- sense organ** One, like the eye or ear, which contains receptors.
- sensitivity** Susceptibility to stimulation.
- sensorimotor** Designation of any behavior that is considered in terms of its afferent (sensory) and efferent (motor) components. Any overt act initiated by receptor processes is sensorimotor. Also see *perceptual-motor habit*.
- sensorium** A term sometimes used to represent the sensory structures and functions of the cerebral cortex. The sensory cortex.
- sensory adaptation** Adaptation of some sensory function, as in dark adaptation, where objects not observed at first, gradually become visible. See *adaptation*.

- sensory habits** Those learned as aspects of sensory discrimination.
- sensory neuron** One connected with a receptor and responsive to sensory stimulation; otherwise known as an *afferent neuron*.
- serendipity** Accidental discovery. Finding one thing while looking for something else, as in the discovery of penicillin by Sir Alexander Fleming.
- serial learning** Learning a sequence of responses, where one response sets the stage, as it were, for the elicitation of the next in the series. Examples are running a maze or reciting a poem.
- set** A readiness to perceive or to respond in some way; an attitude which facilitates, or predetermines, some outcome. See *instructional set*.
- shaping behavior** Molding an organism's responses, as in experiments involving successive approximation, where each further approximation to a desired response (like pecking a disk) is reinforced. The same term is sometimes applied to so-called "brain-washing." See *successive approximation* and *brain-washing*.
- sharpening** A term used in discussing rumor. It represents the tendency to distort a story so that, while overall details drop out (leveling) certain others are brought into prominence, making the story more pointed. Thus, if the person involved in the rumor is disliked, the teller is likely to emphasize derogatory details. See *assimilation*, *leveling*, and *rumor*.
- shock therapy** The production of therapeutic convulsions by passing an electric current through the patient's head or by injecting him with large doses of insulin or convulsive drugs. Used in the alleviation of certain mental illnesses.
- sigma** ( $\sigma$  or *S.D.*) The standard deviation of a distribution. In a normal distribution, 68 per cent of all cases fall between plus and minus one sigma.
- skeletal muscles** Those on the outer body which, when stimulated, move parts of the skeleton, like an arm or leg.
- skewed distribution** A frequency distribution in which measurements are much more frequent toward either end than toward the middle. Compare *normal curve*.
- skill** Proficiency developed through learning. May be motor (as in riding a bicycle), verbal (as in reciting), and both (as in typing).
- social behavior** That which is influenced by or influences the behavior of others; behavior involving interaction of individuals or groups.
- social climate** Used in various ways to represent such features of group activity as overall morale, feeling of togetherness or its lack, the general psychological atmosphere that prevails. Different social climates were produced in studies of small groups subjected to democratic, authoritarian, and laissez-faire leadership. The term is sometimes used as synonymous with cultural or social environment. See *social environment*.
- social conditioning** Learning in a social context.
- social environment** That involving influences from others. These do not, however, need to be present in person. They may influence us through what they have written or recorded in some other way. See *social field*.
- social facilitation** This is said to have occurred whenever the individual in a group situation exceeds the performance level characteristically present when he works alone. It does not necessarily mean that he is more efficient in the group situation, for he may have an increased output but make more mistakes.
- social field** Sometimes used as synonymous with social environment. However, Lewin and his followers have given it a special meaning, which was involved in our discussion of social field analysis. This meaning broadens the term to include not only others present at the time, but also those symbolically present—like parents or teachers who, though absent, exert an influence as, for example, when one thinks of what they might expect him to do under the circumstances. The "great cloud of witnesses" with which the writer of Hebrews (12:1) felt himself surrounded (the prophets, Christ) was, in this sense, part of his social field.
- social heritage** What has been transmitted to

- us from earlier generations, but through social rather than biological avenues.
- social intelligence** The ability to get along well in social situations.
- social interaction** The interplay between individuals or groups; social behavior.
- social maturity** The degree to which the individual has attained independence of parental and other adult ministrations.
- social motives** Those originating in what one learns from others.
- social movement** See *mass movement*.
- socialization** Learning to conform to group ways; acquiring a specific culture.
- socio-cultural influences** Social influences derived from, or dictated by, the culture.
- sociogram** A graphic representation of the results obtained with a sociometric questionnaire.
- sociometric questionnaire** One dealing with interpersonal relations. For example, the person tells with whom he would most like to carry out certain activities and with whom he would least like to carry them out.
- sociometry** See *sociometric questionnaire*.
- somaesthetic** Pertaining to body feeling, or to sensitivity originating in the skin, muscles and body cavity.
- somatic** Pertaining to the body.
- somatotonia** Temperament characterized by marked vigor, directness of manner, competitiveness, need for action.
- somatotypes** Types (or dimensions) of physique according to Sheldon's system in which the somatotype 1-1-7, for example, is low in the endomorphic, low in the mesomorphic, and high in the ectomorphic dimension.
- soul** The psyche of the Greeks. Originally an ethereal presence manifested in behavior and experience and synonymous with what was later called *mind*; in its later (religious) meaning, the disembodied spirit. Also closely related to our present-day concept of the self.
- sound waves** Air vibrations which, when they activate auditory receptors, give rise to tones and noises.
- sour grapes reaction** A form of rationalization in which the individual expresses satisfaction that he did not do what he really wanted to do, or that the things he really wants are not worth the getting.
- space perception** Perceiving or otherwise reacting to the size, distance, or depth aspects of the environment.
- spatial maze** A labyrinth (the most common type of maze) in which different turns occur at different places; contrasted with a temporal maze, where different turns are made in only one place — the bifurcation at the end of the central alley.
- specific hunger** Hunger for such specific food-stuffs as fat, protein, or salt.
- spectrum** The spread of colors perceived when white light is passed through a prism. It has red at one end and violet at the other.
- speech** Verbal language, as represented in talking and in writing. A form of communication.
- sphygmomanometer** Instrument such as the doctor uses for finding blood pressure, which is part of a lie detector, and which is used for studying blood-pressure changes in feeling and emotion.
- spinal cord** The part of the central nervous system which runs up the spine as far as the medulla.
- spontaneous movement** Movement without apparent stimulation. Behavior "emitted" by the organism. See *emitted response*.
- spontaneous recovery** Return of a conditioned response after apparent extinction.
- standard deviation (S.D.)** A statistical index of the variability within a frequency distribution. Also known as *sigma*.
- standard error of a difference** A statistical index of the probability that a difference between the means of two samples is a true difference, i.e., greater than zero.
- standard error of a mean** A statistical index representing the probability that a sample mean is truly representative of the true mean; i.e., that of the total population from which the sample was drawn.
- standardization of tests** Developing definite procedures and methods of scoring and evaluating tests.
- Stanford-Binet test** A widely used individual verbal test of intelligence — an American revision (Terman and Merrill at Stanford University) of the Binet-Simon test.
- star** In sociometry, the person chosen by all (or most) of the group. Compare *isolate*.

- startle pattern** The overall and partially unlearned bodily reaction immediately following onset of sudden stimulation, like a pistol shot.
- static sense** That involved in maintaining equilibrium through stimulation of non-auditory receptors of the inner ear.
- statistics** Mathematical procedures for analyzing and interpreting groups of measurements.
- status** One's standing in the group. Also see *prestige*.
- status symbol** Something that indicates a person's status. An expensive car is, for example, taken by many as a status symbol. Low status may be symbolized by such things as wearing shabby clothing and carrying a lunch box to work.
- stereophonic effects** Artificial reproduction of sounds, and presentation of these to the two ears, so that they simulate the spatial aspects of the sounds of everyday life, as in cinerama and other specialized types of motion picture projection, as well as stereophonic records.
- stereoscope** Instrument with which tridimensional effects are produced by stimulating each eye with a picture representing what it would see under normal binocular conditions.
- stereotyped behavior** That which follows substantially the same pattern whenever elicited.
- stimulus** Any factor inside or outside of the organism, but external to the living cell groups under consideration, which initiates activity of some kind.
- stimulus generalization** When a response has been conditioned to a particular stimulus, say a tone of 256 cycles, or vibration on a particular part of the skin, it is also elicited by other somewhat similar stimuli.
- stirrup** Small stirrup-shaped ossicle of the inner ear, attached to the oval window.
- strategy** The procedure adopted in an effort to achieve some goal, like the solution of a problem. See *partist strategy*, *wholist strategy*.
- stress** Tension or conflict.
- stress interview** One designed to discover an individual's ability "to take it." He is placed on the defensive by, for example, reflections on his character.
- stressor** Anything producing stress, bodily or mental. See *general adaptation syndrome and stress*.
- stroboscope** Device on which a moving pattern seems to stand still, or to reverse its direction, depending upon the speed of movement and the rate at which the light with which it is viewed is flashing on and off.
- structural disorders** Those with an organic basis, like destruction of nerve tissue or defective glandular functioning. Contrasted with *functional disorders*, which have no apparent organic basis.
- stylus moze** A labyrinth threaded with a pencil or stylus.
- subconscious** Generally speaking, what is below the level of awareness. As Freudians use this term, it refers to a hypothetical region of the mind which serves as a repository of repressed and other experiences which, while influencing behavior in important ways, seldom (if ever) comes into consciousness (awareness). Experiences which readily come to awareness are said to be in the preconscious. See *preconscious*. The term *unconscious*, merely referring to that of which we are not aware at the moment, is more widely used. See *unconscious motivation*.
- subject** The organism on which an experiment is performed and whose responses are the dependent variables of the experiment.
- subjective** Known only to the individual himself; not directly observable by others; private. Contrasted with *objective*, or socially observable. How a pain feels to me is subjective, but my cry, since others may witness it, is objective.
- sublimotion** Satisfying a motive indirectly but in a socially acceptable manner.
- subliminal** Below the level of awareness, below the threshold of stimulation, as when an auditory or visual presentation is too weak to have an effect, or at least an effect of which the individual is aware.
- substitution learning** Learning to substitute one symbol for another as in deciphering a code.
- subvocal speech** Talking silently to oneself, as in thinking with words.
- successive approximation method** The method of reinforcing every response (operant)

- which more closely approximates a desired response than the one which just preceded it. Thus a pigeon may be rewarded whenever its pecking comes closer to the disk which the experimenter wants it to peck. See **shaping behavior**.
- suggestion** Something which prompts an individual to react in an uncritical manner. Usually of a verbal nature, as in hypnotic suggestion. See **hypnosis**.
- superego** Internal control (or self-criticism) derived from parental and other early influences. See **conscience**.
- surface traits** Those personality characteristics which are readily apparent, like an individual's sociability or his shyness.
- suspensory ligaments** Fibrous tissues holding the lens of the eye in place.
- symbolic processes** Those which represent, or can substitute for, aspects of past experience. Images and words are thus symbolic. Thought processes are symbolic in that they involve the implicit manipulation of external objects, situations, and relationships.
- sympathetic nervous system** The division of the autonomic system which plays a predominant role in emotion and which functions in opposition to the parasympathetic system.
- synapse** The junction where nerve impulses pass from one neuron to another.
- syndrome** A group of symptoms which characterize a particular disorder.
- syntax** The order in which words, phrases, clauses and so on are put together in the language. Rules governing sentence construction.
- system of psychology** A way of ordering the facts of psychology so that they have meaning in relation to each other. A theoretical model which embraces as many relevant facts as possible and serves as a framework to be filled in as new information is obtained. The various **schools of psychology** were designed to systematize psychological knowledge and point the way for further research. The newer **miniature systems** focus upon particular fields of psychology (like the field of learning) rather than attempting to embrace everything psychological.
- systolic blood pressure** That correlated with the contraction (systole) of the heart. Compare **diastolic blood pressure**.
- T-maze** A maze pathway constructed of T-shaped units. A multiple-T-maze has several such units.
- tabes dorsalis** Injury to the dorsal columns of the spinal cord, ordinarily by syphilis and resulting in a motor incoordination known as **locomotor ataxia**.
- tabetic gait** A jerky gait associated with advanced tabes. Locomotor ataxia. See above.
- tabula rasa** Locke's concept of the mind as analogous, initially, to a blank sheet on which experience makes its impressions.
- tachistoscope** Any device which exposes visual material (pictures, digits, letters, words, etc.) for brief controlled time intervals.
- tact** A term used by Skinner to represent verbalizations which name, symbolize, or otherwise represent aspects of the individual's world. It comes from the idea that these verbalizations form, so to speak, a type of "contact with" the things or events symbolized. Compare **mand**.
- taste** Specialized chemical sense whose receptors are in the tongue.
- taste buds** Receptors for taste stimulation on the surface of the tongue.
- tectorial membrane** Structure in the cochlear canal of the inner ear into which the hair cells of Corti project.
- temperament** Such aspects of personality as joviality, moodiness, tenseness, and activity level are referred to rather loosely as expressions of a person's temperament. The term has an emotional connotation.
- temperature senses** Those of warmth and cold, from which heat is perhaps synthesized.
- temporal lobes** Those of the cerebrum below the fissure of Sylvius (adjacent to the temples). They contain auditory and auditory association areas.
- temporal maze** One in which the subject is required to make different turns in the same place, like two to the right followed by two to the left. Used in the double alternation test of reasoning ability.
- tension** The state of being stretched or under pressure, as in the case of muscular con-

- traction. Also used to represent experienced strain, as when needs are not satisfied, frustration is present, or one waits to hear the outcome of some critical event.
- test** An examination designed to reveal the relative standing of an individual in the group with respect to intelligence, personality, aptitude, or achievement.
- test battery** A group of tests combined for a particular purpose.
- testimony test** The subject views a pictured or actual situation and then tells from memory what he has witnessed.
- testosterone** Secretion from the testes important for the sexual development and motivation of male organisms. The male sex hormone.
- thalamus** Structure between the brain stem and cerebrum which serves as a switchboard mechanism to relay sensory impulses to the appropriate regions of the cerebral cortex and which, in itself, mediates a primitive level of sensitivity and modifiability. Usually regarded as the upper part of the brain stem.
- thematic apperception test (T.A.T.)** One which requires the subject to make up stories appropriate to a series of pictures and, from these themes, gives an indication of basic personality structure.
- therapy** A procedure designed to cure or alleviate some disorder.
- thinking** Manipulating aspects of past experience implicitly, as in recalling (thinking of something), daydreaming, and reasoning. In large measure, at least, a form of subvocal speech.
- thirst** The experience or condition associated with inadequate intake of liquids.
- thought processes** See thinking.
- threshold** In the most general sense, this is the point at which an experience (or response) just barely occurs. A more specific term is **absolute threshold**. A stimulus of threshold strength is one which, if it were weaker, would have no typical effect. A **difference threshold** (or **threshold difference**) is one just barely perceptible, the **just noticeable difference**, or **j.n.d.** The **terminal threshold** is the upper limit of sensitivity, the point beyond which further increases in intensity have no typical effect. By "typical effect" in these definitions is meant no increment to the sense being studied. If increasing the intensity of light stimulation brings pain, that is not a visual effect, hence not typical for this kind of stimulation.
- thwarting** Placing barriers in a person's way so that he cannot satisfy some motive, or so that he has unusual difficulty in satisfying it. Frustrating him.
- thyroid gland** Endocrine gland situated near the windpipe. Its secretion (thyroxin) is important for metabolism. A marked deficiency in early life may produce the form of feeble-mindedness known as **cretinism**.
- thyroxin** The secretion of the thyroid gland, or a synthesized product of the same. See **thyroid gland**.
- tic** A nervous twitch of a muscle or muscle group.
- timbre** Sound quality, as in the difference between a piano and a 'cello playing the same note. A function of the complexity of sound waves, i.e., the overtones produced.
- token rewards** Secondary reinforcers, like coins or poker chips which can be used to "purchase primary satisfactions.
- tone** Periodic sound to which a particular pitch can be assigned, as compared with noise, which is aperiodic.
- tonic immobility** Animal hypnosis, an immobility of the body brought on by some sudden emotion-provoking stimulus or by certain other stimuli which render an organism motionless.
- tools** Devices through which the organism extends the range of its senses, or increases its strength and dexterity in coping with its environment.
- topological psychology** That which considers the behavior of the individual at any moment as a function of the attracting and repelling forces (positive and negative valences) in his psychological environment (or life space). See **social field**, **valences**, **vectors**.
- tracking behavior** Behavior controlled by a moving target. In **compensatory tracking**, one attempts, through compensatory movements, to keep the "target" stationary, as when the speedometer is kept as close as possible to 50 miles per hour. **Pursuit tracking** is that in which the aim is to keep

- on the target. A gunner trying to hit a moving object is pursuit tracking.
- training** This involves observing others who are skilled in the performance to be learned and/or following instructions. Compare *practice*
- traits** Relatively constant aspects, characteristics, or dimensions of behavior. Usually applied to personality and exemplified by such terms as introversion, dominance, sociability, persistence and honesty.
- tranquilizer** Anything which makes a person more tranquil, quiet, or relaxed. The so-called "tranquilizers" much in evidence today are drugs which have the above effect. The more potent tranquilizers are used to relax the mentally ill. Milder tranquilizers are often prescribed for release of tensions in otherwise normal people.
- transfer** A carry over from one habit to another. This may be *positive* in effect, as when learning one thing facilitates the learning of something else; or its effect may be *negative*, as when the first habit interferes with acquisition of the other.
- tremor** A limited muscular spasm like the trembling or quivering of the hand.
- trial** One run through the maze, one reading of something to be memorized, and so on. A practice period.
- trial-and-error** Term used to represent the apparently random, haphazard, hit-or-miss exploratory activity which often precedes the acquisition of new adjustments. It may be *overt*, as exemplified in a rat's running here and there in a maze, or *implicit*, as when one thinks of this and then that way of coping with a situation. Contrasted with planned or insightful behavior.
- tridimensional vision** That involving discernment of depth or distance. Present artificially in the stereoscope or in a 3D motion picture.
- tropism** An unlearned orienting movement of the whole organism which causes it to move toward or away from the stimulus. Examples are a moth flying into the flame (positive phototropism) and a cockroach running toward the dark (negative phototropism).
- trompe-l'œil art** That which "fools the eye" as in two-dimensional pictures which have a tridimensional effect.
- tympanic canal** The descending canal of the cochlea at the lower end of which is the round window.
- tympanic membrane** The ear drum.
- typology** The attempt to classify persons into types — such as in terms of physique, temperament, and introversion-extraversion.
- ultraviolet light** That with a wave length shorter than 400 millimicrons (violet), hence invisible.
- unconditioned response** The original, or inborn response, like salivation stimulated by food in the mouth, withdrawal from an injurious stimulus, or the contraction of the pupil to light, ordinarily reflex in character.
- unconditioned stimulus** The stimulus which arouses an unconditioned response, as defined above.
- unconscious** Below the level of awareness. Compare *subconscious* and *preconscious*.
- unconscious motivation** Urges of which the individual is not aware.
- universality** The characteristic of being universal, present in all normal members of the species. Not a sure criterion of innateness because all normal members of a culture may have certain learned responses in common.
- unlearned response** One that, rather than being acquired (i.e., dependent upon the learning process), is inborn, innate, inherited; dependent upon maturation for its appearance.
- USES test battery** That used by the United States Employment Service to screen applicants for jobs. An aptitude battery.
- utricle** Part of the vestibule, just below the semicircular canals. It plays a part in static sensitivity.
- vagus nerve** The 10th cranial nerve. Literally, the "wandering nerve" which constitutes an important part of the parasympathetic system. It connects with most of the viscera.



- valences** Attracting and repelling "forces" in the individual's psychological environment.
- validation** Determination of the validity of tests (see below), usually with correlation procedures.
- validity** A test is said to be valid (or to have validity) when it actually does what it has been designed to do, such as predict success in school or in some vocation or avocation. It is valid to the degree that test scores correlate with criteria of success.
- values**, as aspects of personality. Things that the individual holds as good, worthwhile, or important. The aspects of life to which he gives most weight, as in the Allport-Vernon-Lindzey *Study of Values*, where the relative weight given to things economic, religious, aesthetic, etc., is discerned.
- variable interval reinforcement** See *schedule of reinforcement*.
- variable ratio reinforcement** See *schedule of reinforcement*.
- variables** What we can manipulate or measure, as in the case of independent and dependent variables in an experiment.
- variability** The degree to which individuals, or measurements in a frequency distribution, differ from the average. The standard deviation is a measure of variability.
- vectors** In topological (or vector) psychology, direction of psychological forces resulting from the interplay of attracting and repelling factors (positive and negative valences) in an individual's psychological environment. See *topological psychology*.
- ventral root** The location of cell bodies of the motor (efferent) division of a spinal nerve. Designated *ventral* because it is toward the front (belly) of the organism.
- verbal** Pertaining to language.
- verbal behavior** That involving language; speech, written or spoken.
- verbal community** The group which sets the pattern for our verbal behavior and reinforces conformity with this pattern.
- verbal skills** Linguistic habits, as in speaking, writing, reading, or reciting.
- verbalization** In relation to problem solving — figuring out the solution to a problem and putting it into words, as when the person says, "the solution is to go twice to the right, then twice to the left."
- verification stage** In creative thinking — testing out one's invention to see if it really works.
- versatility** Facility or ease in accomplishing a variety of things. A versatile person is one who can do many things well. The ability to vary in desirable directions instead of being stereotyped. Flexibility.
- vertebrates** Animals with backbones.
- vestibule** Structure at the base of the semicircular canals which functions especially in perception of rectilinear motion.
- vestibular canal** The ascending canal of the cochlear at the origin of which the oval window, with adjacent stirrup, is located.
- vigilance** Alertness, being wide awake, paying attention.
- viscera** Organs of the body cavity, like the stomach, spleen, and intestines.
- visceral afferent fibers** Those which carry nerve impulses from the viscera to the central nervous system, hence sensory.
- visceral reactions** Stomach contractions, secretion of adrenin, and other responses of visceral organs. Visceral reactions underlie such experiences as nausea and "butterflies" in the stomach.
- visceratonia** Personality dimension characterized by preoccupation with the viscera (especially the stomach); viz., unusual enjoyment of eating.
- visible spectrum** That region between 400 and 700 millimicrons which is perceived by the human eye as a series of hues ranging from violet to red.
- visual accommodation** Change in the lens so as to focus light from sources at different distances from the eye and thus to form sharp images on the retina.
- visual cliff** An apparent, but not actual, drop off in a situation designed to test the depth or distance discrimination of infants. They crawl on a plate of glass the under side of which is backed with linoleum for a certain distance. At the "cliff" the linoleum is dropped some distance below the glass, and most infants refuse to go beyond this point.
- visual purple** A photochemical substance in the rods which is otherwise known as *rhodopsin*.

- vitreous humor** The transparent jelly-like substance between the lens and the retina of the eye.
- vocal cords** Membranes in the larynx, vibrations of which produce voiced sounds.
- vocal play** Vocalization as in babbling.
- vocality** A characteristic possessed by tones that sound like vowels.
- vocalization** Sound made with the vocal mechanisms; not speech, however, until it has communicative significance.
- vocational guidance** Telling the individual, in terms of his intelligence, aptitudes, interests, etc., as well as job opportunities, the fields in which he is most likely to succeed.
- vocational interest blank** An inventory devised by Strong which reveals the person's *liking for, dislike for, or indifference to* activities associated with many vocations and avocations. The pattern of interests thus revealed is evaluated in terms of the pattern of interests of people successful in various vocations.
- vocational selection** Picking out, in terms of the requirements of a job, the people best fitted to do it. Selection of such people is done with aptitude tests and perhaps other selection devices, including interviews.
- voice** As the term was used in this text, it referred to any sound made by the vocal cords. These are voiced sounds. Whispered sounds are without voice.
- volley theory** The theory that the pitch of sounds (at least between 1000 and 5000 cycles) is determined by the frequency of the volleys of nerve impulses reaching the brain. These volleys are carried by groups of nerve fibers, not by a single fiber. Intensity, according to this theory, is determined by the number of impulses per volley. Also see *frequency theory of hearing*.
- voluntary** Done with intention, as compared with *involuntary* acts, over which the individual has no control.
- wave length** The distance between two corresponding positions in a wave, as from crest to crest.
- waxy flexibility** Found in some forms of hysteria and in catatonic schizophrenia. The patient's arm, hand, or some other part of his body can be placed in a certain position, and it is held there for what is, at times, a considerable period. It appears that he is being molded "like wax."
- Weber's law** This holds that, whether or not an increase or decrease in intensity of stimulation is discriminated depends upon the ratio of the change in stimulus intensity to the intensity of stimulation existing prior to the change.
- Wechsler Adult Intelligence Scale (WAIS)** An individual test designed for adults. It includes both verbal and performance items. (Formerly called the "Wechsler-Bellevue Scale.")
- Wechsler Intelligence Scale for Children (WISC)** Much like the adult scale in content but graded downward in difficulty and separately standardized for use with children.
- white matter** Found in the outer regions of the spinal cord and in other areas in the central nervous system which appear white. It gets its name from the prevalence of the white fatty sheath (myelin) of the nerve fibers in these areas.
- wholist strategy** That of proceeding in accordance with an inference, hypothesis, or principle based upon all available information, as in experiments on categorizing (concept formation) where all relevant stimuli (possible cues) rather than only some of them are utilized. Compare *portist strategy*.
- will power** Inferred from persistence in following out some line of activity despite barriers or distracting influences and also from decisiveness in making difficult choices.
- will to learn** The intention to learn.
- will to power** The mastery, or self-assertive motive.
- word blindness** The aphasia (otherwise known as *alexia*) in which an individual loses ability to understand the meaning of written words, or in congenital alexia or dyslexia is born with a brain condition which makes learning to read unusually hard.
- word deafness** Like word blindness except that the meaning of spoken words is lost.
- worry** An anxious state characterized by un-

certainty and unpleasantness. Also see **anxiety**.

**X-chromosome** One of the sex chromosomes. The male has only one, the female two.

**Y-chromosome** One of the sex chromosomes, possessed only by males.

**Young-Helmholtz theory of color vision** This theory assumes that there are three primary colors (red, green, and blue) with cones especially receptive to the wave lengths of each. Yellow is assumed to result from simultaneous activation of the "red" and "green" cones.



The reader who turns to this appendix knows how to make a frequency distribution and plot a frequency distribution curve. He is also acquainted with certain characteristics of such curves and with what these reveal about the distribution of individual differences. Here we delve a little more deeply into statistics, showing how to do some simple calculations. Further use is made of the memory span data.

### MEASURES OF CENTRAL TENDENCY

When we ask, "What is the typical memory span?", the *mode* of 6.00, with which we are already familiar, may be given. More commonly, however, either of two other measures of central tendency is given. Most frequently, this is the average or *mean*.

#### The mean

Calculation of the mean is illustrated below. One may either add all scores and divide by the number, in this case 100, or he may use grouped data, as illustrated. Here each score (*s*) is multiplied by its frequency (*f*), the sum ( $\Sigma$ ) of the products is obtained, and this is divided by the number of cases (*N*).

Score	<i>f</i>	<i>f</i> × <i>s</i>
9	1	9
8	4	32
7	24	168
6	36	216
5	28	140
4	6	24
3	1	3
<hr/>		<hr/>
<i>N</i> = 100	$\frac{\Sigma(f \times s)}{N} = \frac{592}{100} = 5.92$	

The mean, as calculated, is 5.92. In an experiment like ours, however, where the subject could not make a fractional score, it would be better to regard the mean as 6.00, the nearest whole number.

#### The median

The median is, by definition, the middlemost score, the score on each side of which 50 per cent of the cases in the distribution fall. Its calculation is given below. Observe that, in our distribution, the 50th score from the top or bottom is assumed to fall within the interval 5.5 and 6.5. Starting at 5.5 we go up 50-35 (or 15) cases to reach the 50th. Since the interval includes 36 cases, we add 15/36ths to 5.5, which gives the median score as 5.92. Starting from the other end of the distribution and subtracting from 6.5, we get the same result. As in the case of the mean, a median of 6.00 would be considered most representative for our data.

Score	<i>f</i>	
9	1	} 29 cases
8	4	
7	24	
6.5		
6	36	
5.5		
5	28	} 35 cases
4	6	
3	1	
<hr/>		
100		

$$\begin{aligned}
 \text{Mdn} &= 5.5 + \frac{50 - 35}{36} \\
 &= 5.5 + \frac{15}{36} \\
 &= 5.5 + .4167 = 5.92 \\
 &\quad \text{or} \\
 \text{Mdn} &= 6.5 - \frac{50 - 29}{36} \\
 &= 6.5 - \frac{21}{36} \\
 &= 6.5 - .58 = 5.92
 \end{aligned}$$

In a completely normal distribution the mode, median, and mean are identical. It is very rarely, however, that actual measure-

ments more than approximate a normal distribution. Hence the three measures of central tendency, although often of similar value, are seldom interchangeable.

When a distribution is skewed, the mode, mean, and median may differ considerably. Then the investigator has to decide which measure is most representative. For further statistical analysis such as we are about to describe, however, the mean is customarily used.

### VARIABILITY

In the text we considered variability only as it could be presented graphically; that is, as represented by the spread of the total distribution. This is essentially the measure of variability known as the *range*, which is the difference between the highest and the lowest score in the distribution. In statistical analysis, however, a more accurate measure of variability is desirable—one which represents not merely the spread of the distribution but the degree to which scores are clustered around the mean. This measure is known as the *standard deviation* of the distribution. It is referred to as the S.D. or merely as  $\sigma$  (Sigma).

A standard deviation is found, as illustrated below, by obtaining the deviation ( $D$ )

of each score from the mean, by squaring these deviations ( $D^2$ ), by adding them ( $\Sigma D^2$ ), by dividing by the number of cases ( $N$ ) and by extracting the square root ( $\sqrt{\frac{\Sigma D^2}{N}}$ ). Our calculation shows  $\sigma$  for the memory span data to be approximately 1.045, or 1.05.

The standard deviation is represented graphically as a distance along the abscissa (the score dimension) of the distribution curve. It is not properly used, however, unless there are many scores distributed symmetrically. Only to the degree that our distribution of scores approximates a normal distribution, are we justified in speaking of the probable location of given scores or percentages of scores within a given range. This is because, when we mark off  $1\sigma$  on each side of the mean of a normal probability curve, 68 per cent of all scores fall within this range. When we mark off  $2\sigma$  on each side of the mean, approximately 95 per cent of the cases fall within these limits. Plus or minus  $3\sigma$  takes in over 99 per cent of the cases. It should be clear, then, that if  $\sigma$  is large, the scores are widely scattered from the mean. If it is very small, however, scores are piled up, or concentrated closely around the mean. Thus, if we had found a significantly smaller  $\sigma$  for women than for men, we could have concluded that women are less variable, with respect to memory span, than men. Comparison of their respective sigmas could also tell us such things as what per cent of men exceeded the highest score made by women.

### STANDARD SCORES

When we know the  $\sigma$  of a distribution we can also place the individual better than by saying merely that his score is above or below average; or even better than by stating its percentile position. We can now derive what is called a *standard score*. This is obtained by dividing the individual's deviation from the mean by  $\sigma$ . Thus the person with a memory span of 8 has a score 2.08 points above the mean (5.92). The  $\sigma$  is 1.045. Thus he has a standard ( $Z$ ) score of approximately + 1.9 (see Figure).

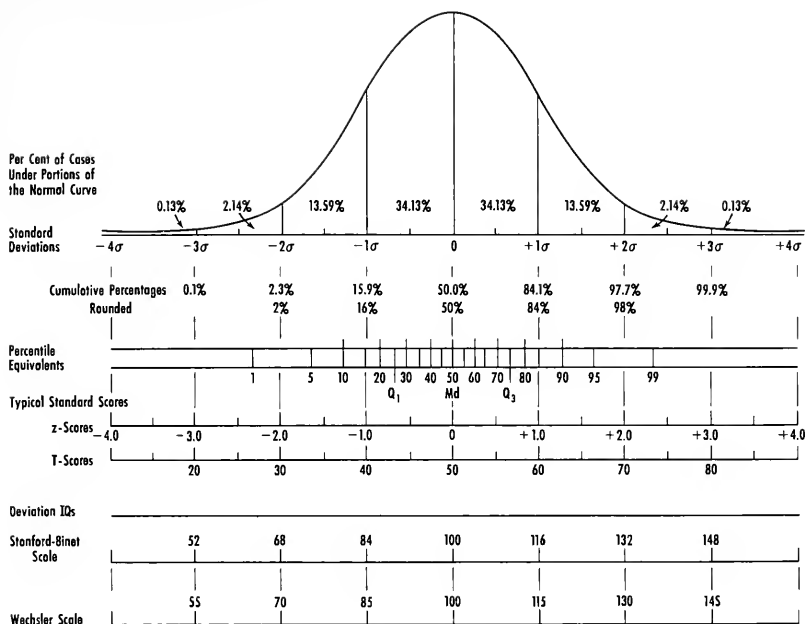
Score	<i>f</i>	<i>D</i>	<i>D</i> <sup>2</sup>	<i>fD</i> <sup>2</sup> *
		Deviation from Mean	Deviation Squared	
9	1	3.08	9.4864	9.4864
8	4	2.08	4.3264	17.3056
7	24	1.08	1.1664	27.9936
6	36	.08	.0064	.2304
5	28	.92	.8464	23.6992
4	6	1.92	3.6864	22.1184
3	1	2.92	8.5264	8.5264
100			$\Sigma fD^2 = 109.3600$	

$$M = 5.92$$

$$\sigma = \sqrt{\frac{\Sigma fD^2}{N}} = \sqrt{\frac{109.3600}{100}} = \sqrt{1.094}$$

$$= 1.045 \text{ (approx.)}$$

\* Note that, instead of taking the deviation of each separate score, we took the deviation of one score of each magnitude and multiplied it by its frequency.



**A Normal Distribution Curve.** This curve shows the per cent of cases under segments of the curve (marked off in terms of sigma) and also percentiles and standard scores.

One advantage of standard scores, when raw scores are similarly distributed, is that they are comparable from one test to another.\* Under these circumstances, the person whose standard score on two tests is 2.5 has comparable status on both tests.

Another advantage of standard scores is that they may be averaged for different tests to show the individual's overall standing. This is because they reduce all measurements to a common scale of units — i.e., deviation units

based upon properties of the normal distribution curve. It would be nonsense to add scores on arithmetic, science, and reading in order to derive an average measure of school performance. If such diverse measures were reduced to standard scores, however, it would be quite sensible to average them. Thus a person with a Z score of 1.2 on one test, of 2.3 on another, and of 2.5 on another would have overall status indicated by a Z score of 2.0.

In the test we did not consider the reliability of a mean, or of any other measure of central tendency. The meaning of this concept and its significance in statistical analysis is given brief consideration in the following discussion.

\* Sometimes, in order to remove minus signs, testers multiply standard scores (Z) by 10 and add 50. T scores are thus derived. This has the effect of making each S.D. = 10 and the Mean = 50. Thus a Z-score of 1.9 becomes a T-score of 69.

## THE RELIABILITY OF A MEAN

How closely did the group of students who took our memory test represent college students in general? The only way we could answer this question with assurance would be to test all college students. This would, of course, not be possible. However, if we were careful to select our subjects randomly from the larger student population, we could estimate the probable amount of error involved in using a limited sample rather than the whole population. This is because we know that chance errors of sampling tend to be distributed according to the normal curve of probability.

As we have seen, the mean memory span of our sample of subjects was 5.92. In another sample taken from the same total population, we might obtain a mean of 6.0, or of 5.8. Were we to continue taking random samples and finding their means, we would discover that these sample means form a normal distribution. The mean of this distribution could be considered the *true mean*—that is, the mean of the larger population from which the samples were taken. The standard deviation of such a distribution of means is called the *standard error*, to distinguish it from the  $\sigma$  of a sample. It provides a measure representing the reliability of the mean.

The size of the standard error of the mean ( $SE_M$  or  $\sigma_M$ ) tells us how much variability we might expect to find in repeated samplings from the larger population. It tells us, in other words, how *reliable* our mean is. We shall see that this reliability can be estimated from our particular sample. We shall also see how (1) the size of the sample taken, and (2) the variability of the subjects in this sample, both influence the degree of confidence we can place in our mean.

The formula for  $\sigma_M$  takes into consideration the two chief factors, other than errors of measurement, which would affect the reliability of the mean. One of these is the *number of cases*. Obviously, the larger the group tested, the greater the probability that the obtained mean is representative of all college students. It can be shown that the square root of the number, rather than the number itself, is significant here. One hundred subjects

give not 100 times the reliability obtained with one subject, but  $\sqrt{100}$ , or 10 times. The other factor which influences reliability is  $\sigma$ . It will be recalled that  $\sigma$  shows how closely scores cluster around the mean. One can readily see that, if the  $\sigma$  of our memory span results were small, which would signify that scores were closely piled up around the mean, our measure of central tendency would be more likely to be representative of students as a whole than if the scores were widely scattered—that is, if  $\sigma$  were large.

The  $\sigma_M$  of our data on memory span was found to be .1045. This was obtained by dividing  $\sigma$  (1.045) by the square root of the number of the subjects ( $\sqrt{100}$ ). A  $\sigma_M$  of .1045, or approximately .10, allows us to say that the mean memory span is  $5.92 \pm .10$ . Reference to a table giving the properties of the normal probability curve shows that we are warranted in saying that the chances are 68 in 100 that the true mean (for an infinitely large sample of college students) would not be likely to fluctuate from the obtained mean more than plus or minus .10. In repeated samples, that is to say, we will be correct 68 times in 100, or 68 per cent of the time, in assuming that the population mean (the *true mean*) will fall between 5.82 and 6.02. Again referring to the characteristics of the normal probability curve, we note that the chances are over 99 in 100 that the true mean will be within the limits of 5.92 plus or minus three times  $\sigma_M$ , or between 5.62 and 6.22.

Precisely why  $\sigma_M$  makes possible such determinations will not be apparent until one has a greater knowledge of statistics than can be presented in an elementary course in psychology. At this stage it is necessary only to get some idea of the kind of information which statistical analysis provides concerning the reliability of the mean.

## RELIABILITY OF A DIFFERENCE BETWEEN MEANS

Suppose an investigator wished to discover whether there is a difference in the learning ability of males and females, or of rats deprived of vitamin B<sub>1</sub> and rats fed a normal diet. He would apply a comparable test to a large



number of comparable individuals from each group. His next step would be to calculate the mean for each group. Suppose that the mean of one group were 95 and that of the other 105. Is this difference of ten points a reliable one? Perhaps in a repetition of this experiment, the difference in means would disappear or even be reversed. Statistical analysis tells us the probability that the true difference is greater than zero.

The measure used here is the standard error of the difference between two means, or  $\sigma_{\text{Diff}}$ . It makes use of  $\sigma_M$ . The reason for this is rather obvious, for the more reliable the two means, the more probable is it that the difference between them is also reliable.

Suppose we found the standard errors of the means of 95 and 105 to be respectively, .6 and .9. Then, as calculated below,  $\sigma_{\text{Diff}}$  would be 1.08. The ratio of this to the actual difference (known as the *critical ratio* or CR) would be 10 over 1.08, or 9.26.

$$\begin{aligned}\sigma_{\text{Diff.}} &= \sqrt{(\sigma_{M_1})^2 + (\sigma_{M_2})^2} \\ &= \sqrt{(.6)^2 + (.9)^2} \\ &= \sqrt{.36 + .81} \\ &= \sqrt{1.17} \\ &= 1.08 \text{ (approx.)}\end{aligned}$$

The CR is interpreted in relation to the properties of a normal distribution. Thus interpreted, it tells us the level of confidence we may have in making certain assumptions about the difference obtained. Psychologists commonly talk about the "1 per cent level of confidence" and the "5 per cent level of confidence." If the CR is more than 2.58, as in our example, a difference as great as that found would occur in repeated sampling less than 1 time in 100. This is another way of saying that 99 per cent of the time we would be correct in assuming that there is a real difference between the two means; the means of the sexes, or of the rats fed a normal diet and those deprived of vitamin B<sub>1</sub>. Such an assumption would be at the 1 per cent level of confidence. A lesser level of confidence is illustrated when, for example, we get a CR of 1.96. This tells us that, if errors due to random sampling alone were present, we would be correct 95 per cent of the time in assuming the existence of a true

difference. Here our assumption would be lowered to the 5 per cent level of confidence.\*

This is only one of several methods for testing the significance of a difference between groups. In a particular research, the method used will depend upon such things as the size of the groups, and how well they are matched. Such methods are considered in courses on statistical analysis and experimental methodology.

## CALCULATION OF CORRELATIONS

There are several methods of calculating a coefficient of correlation. All give similar results, although, under given conditions, certain of them are more conveniently used than others. The *product-moment* method is most widely used. It is preferred when one has a large number of cases (over 30).

One formula for this method is:

$$r = \frac{\Sigma xy}{N \sigma_x \sigma_y}$$

where  $r$  is the coefficient of correlation calculated by the product-moment method;  $x$  and  $y$ , the deviations of  $X$  and  $Y$  scores from their respective means;  $N$ , the number of subjects, and  $\sigma_x$  and  $\sigma_y$  the standard deviations, respectively, of the  $x$  and  $y$  series of deviations. The application of this formula is as follows:

Subjects Errors Deviations Calculation of $\sigma_x \sigma_y$						
	$X$	$Y$	$x$	$y$	$xy$	$x^2$
A	1	2	-2	-4	4	4
B	2	3	-1	-1	1	1
C	3	4	0	0	0	0
D	4	5	1	1	1	1
E	5	6	2	2	4	4
	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>
	15	20	$\Sigma xy = 10$	$\Sigma x^2 = 10$	$\Sigma y^2 = 10$	
$M = \frac{15}{5} = 3$	$M = \frac{20}{5} = 4$	$\sigma_x = \sqrt{\frac{10}{5}}$	$\sigma_y = \sqrt{\frac{10}{5}}$	$= \sqrt{2}$	$= \sqrt{2}$	
$r = \frac{10}{5(\sqrt{2} \times \sqrt{2})}$	$= \frac{10}{(5 \times 2)}$	$= 1.00$				

\* Books on statistics have tables from which such evaluations of critical ratios may be made.

As already indicated by inspection,  $r$  is 1.00. By reversing the figures in either X or Y and following the same procedure, one comes out with  $-10/10$  or  $-1.00$ . As calculated by this method, the  $r$  between X and Z scores is approximately  $-.52$ .

We shall illustrate the *rank-difference* method by correlating the X and Z columns. This method gives a rough estimate of  $r$  and is easier to calculate. The formula for calculating a rank-difference coefficient, Rho ( $\rho$ ), is

$$\rho = 1 - \frac{6\Sigma D^2}{N(N^2 - 1)}$$

where  $\Sigma D^2$  is the sum of the squared differences between the ranks of scores in the two series and  $N$  the number of cases. It is first necessary to determine separately the ranking of individuals in each of the performances to be correlated. The computation is as follows:

Subjects	Errors		Ranks		D	$D^2$
	X	Z	X	Z		
A	1	9	1	5	4	16
B	2	6	2	3	1	1
C	3	3	3	1	2	4
D	4	8	4	4	0	0
E	5	4	5	2	3	9
						$\Sigma D^2 = 30$

$$1 - \frac{6(30)}{5(25 - 1)}$$

$$1 - \frac{180}{5(24)}$$

$$1 - \frac{180}{120}$$

$$1 - 1.50$$

$$= .50$$

The coefficients  $r$  and  $\rho$  are seldom identical, although they are usually similar. The difference occurs because the formula for  $\rho$ , unlike that for  $r$ , ignores the differences in actual magnitude of the scores, dealing with them merely in terms of rank. Tables have been worked out so that one can read off the value of  $r$  for a given value of  $\rho$ . The value of  $r$  for a  $\rho$  of  $-.50$  is, for example,  $-.518$ .

The more closely  $r$  approximates plus or minus one ( $\pm 1$ ) the higher the relationship between the variables correlated. But a coefficient of correlation does not mean per cent of relationship. Percentages of dependence of one variable on another, or of both on some third variable, can be calculated from  $r$ , but except when  $r$  is very high, these percentages are much lower than  $r$ .

For greater detail on statistics the reader might consult Blommers, P., and E. F. Lindquist, *Elementary Statistical Methods*. Houghton Mifflin, 1960. Also see the *Study Manual for Elementary Statistical Methods in Psychology and Education* by the same authors, likewise published by Houghton Mifflin Company.

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## Chapter 10

### The Learning Process

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and "Creative Thought in Artists," *J. Psychol.*, 1937, 4, 53.

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### Chapter 13 Knowing Our World

1. We can make no pretense of knowing what "really exists" beyond the limits of our skin; or, for that matter, within it. This is a problem that has puzzled many learned men. Writing more than 100 years ago, a physiologist said: "It may well be, that sensation consists in the sensorium receiving through the medium of the nerves, and as a result of the action of an external cause, a knowledge of certain qualities or conditions, not of external bodies, but of the nerves of sense themselves." This was J. Müller, as quoted by O'Neil, W. M., in "Basic Issues in Perceptual Theory," *Psych. Rev.*, 1958, 65, 348-361.
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### Chapter 14 Attending and Perceiving

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## Chapter 15

### Communication and Language

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12. Thorndike, E. L., *Animal Intelligence*. Macmillan, 1911.
13. See Helen Keller's *The Story of My Life*. Doubleday, 1903, p. 315.
14. Cassirer, E., *An Essay on Man*. Yale University Press, 1944, p. 35.
15. Langer, S. K., *Philosophy in a New Key*. Harvard University Press, 1942.
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23. Cited in Skinner, B. F., *Verbal Behavior*. Appleton-Century-Crofts, 1957, p. 462.
24. Munn, N. L., *The Evolution and Growth of Human Behavior*. Houghton Mifflin, 1955, p. 344.
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26. This is the view expressed by Mowrer, O. H., "The Psychology of 'Talking Birds'—A Contribution to Language and Personality Theory," in his *Learning Theory and Personality Dynamics*. Ronald, 1950.
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33. Skinner, B. F., *Verbal Behavior*. Copyright © 1957, Appleton-Century-Crofts, Inc. P. 85.
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37. Weaver, W., *op. cit.*, p. 102.
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  45. Osgood, C. E., *et al.*, *op. cit.*, p. 7.
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  48. Osgood, C. E., *et al.*, *ibid.*, p. 329.
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  50. Published in 1955 by The Museum of Modern Art, New York.
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  52. Hall, E. T., *The Silent Language*. Doubleday, 1959. Although this book emphasizes the utilization of time as a

means of nonverbal communication, it is also concerned with other nonverbal, yet communicative, aspects of a culture.

## Chapter 16 Social Behavior

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2. Lorenz, K. Z., "The Companion in the Bird's World," *Auk*, 1937, 54, 245-273; here he speaks of imprinting as a conditioned reaction (p. 262). Also see, by the same author, *King Solomon's Ring*. Crowell, 1952, Chapter 11.
3. This is shown in a film entitled "Action and Reaction" (one of a series called "John Kieran's Kaleidoscope") distributed by Almanac Films, 516 Fifth Ave., N.Y.
4. One of the earliest descriptions of what is now called "imprinting" was given by William James, based upon the earlier observations of D. A. Spalding. See James, W., *Principles of Psychology*. Holt, 1890, Vol. II, p. 396. Craig found that pigeons fed by hand from the time of hatching become fixated upon the hand so that copulation with it is attempted and the normal outlet is neglected. See Craig, W., "The Voices of Pigeons Regarded as a Means of Social Control," *Am. J. Sociol.*, 1908, 14, 86-100. Still other earlier examples of what has come to be called "imprinting" are cited by Hess (see Reference 6).
5. An example is given by Scott, *op. cit.*, p. 179. Hess, E. H., see below, lists several species of birds known to be imprintable and also two mammals, the sheep and guinea pig.
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7. Hess, E. H., in the last-mentioned reference, p. 90.
8. Hess, E. H., first citation in Reference 6, p. 141.
9. Schjelderup-Ebbe, T., "Social Behavior of Birds," in Murchison, C. (Ed.), *Handbook of Social Psychology*. Clark University Press, 1935.
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- urement of a Social Hierarchy in *Gallus Domesticus*," *J. Gen. Psychol.*, 1935, 12, 3-39.
11. Murchison, *op. cit.*, pp. 21-22.
  12. On intelligence in relation to the pecking order, see Katz, D., and A. Toll, "Die Messung von Charakter und Begabungsunterschieden bei Tieren," *Zsch. f. Psychol.*, 1923, 93, 287-311.
  13. See Scott, *op. cit.*, pp. 172-176.
  14. Scott, J. P., *Aggression*. University of Chicago Press, 1958, p. 118.
  15. See especially Thrasher, F. M., *The Gang*. University of Chicago Press, 1927; and Whyte, W. F., *Street Corner Society*. University of Chicago Press, 1943.
  16. See the discussion by Kimball Young (*Social Psychology*, 3rd Ed., Appleton-Century-Crofts 1956, pp. 502 ff.) on prejudice and status in race relations.
  17. Reprinted by permission of the publishers, Abelard-Schuman Limited, from *The Social Life of Animals* by W. C. Allee. Copyright 1958. P. 204.
  18. *Op. cit.*, p. 204.
  19. See the work of J. C. Welty (on fish) and S. C. Chen (on ants) as reported in W. C. Allee, *op. cit.*, pp. 98-102.
  20. Harlow, H. F., "Social Facilitation of Feeding in the Albino Rat," *J. Genet. Psychol.*, 1932, 41, 211-221; Rasmussen, E. W., "Social Facilitation in Albino Rats," *Acta Psychol.* (Hague), 1939, 4, 295-304; and Bruce, R. H., "An Experimental Analysis of Social Factors Affecting the Performance of White Rats," *J. Comp. Psychol.*, 1941, 31, 363-377.
  21. Leuba, C., "An Experimental Study of Rivalry in Young Children," *J. Comp. Psychol.*, 1933, 16, 367-378.
  22. A good reference here is Wheeler, W. M., *Ants, Their Structure, Development and Behavior*. Columbia University Press, 1913. An Ann Arbor Science Paperback by W. Goetsch, *The Ants*, 1957, also deals with social behavior.
  23. Examples are given in Alverdes, F., *Social Life in the Animal World*. Harcourt, Brace, 1927. Also see the discussion by Hebb, D. O., and W. R. Thompson in Lindzey, G., *Handbook of Social Psychology*. Addison-Wesley, 1954, pp. 540-543.
  24. This experiment is shown in a film by O. H. Mowrer: "An Experimentally Produced Social Problem in Rats"; it is distributed by the Psychological Cinema Register, Pennsylvania State University.
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  27. Wolffe, D. L., and H. M. Wolffe, "The Development of Cooperative Behavior in Monkeys and Young Children," *J. Genet. Psychol.*, 1939, 55, 137-175.
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  31. Kinsey, A. C., W. B. Pomeroy, and C. E. Martin, *Sexual Behavior in the Human Male*. Saunders, 1948, Chapter X.
  32. For further information, see Bavelas, A., "Role Playing in Management Training," *Sociatry*, 1947, 2, 183-191; and Maier, N. R. F., *Principles of Human Relations*. Wiley, 1952, Chapters 4 and 5.
  33. See Sarbin, *op. cit.*, p. 225.
  34. On this, see Sarbin, *ibid.*, pp. 248-255. From Gardner Lindzey, *Handbook of Social Psychology*, 1954, Addison-Wesley, Reading, Mass.
  35. These and similar instances are cited in Killian, L. M., "The Significance of Multiple-Group Membership in Disaster," *Am. J. Sociol.*, 1952, 57, 309-313.
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  37. Triplett, N., "The Dynamogenic Factors in Pacemaking and Competition," *Am. J. Psychol.*, 1898, 9, 507-533.
  38. Lewin, K., *Resolving Social Conflicts*. Harper, 1948, p. 84.

39. Lewin, K., *Field Theory in Social Science*. Harper, 1951, Chapter IX.
40. See the preceding book by Lewin and also Leeper, R. W., *Lewin's Topological and Vector Psychology: A Digest and a Critique*. University of Oregon, 1943.
41. Lewin, K., *Field Theory in Social Science*, p. 197.
42. Many such investigations have been carried out by the Survey Research Center for Group Dynamics, originally set up at the Massachusetts Institute of Technology by Lewin and later moved to the University of Michigan. Some of the studies are reprinted in Cartwright, D., and A. Zander, *Group Dynamics: Research and Theory*. Row, Peterson, 1953. Typical of such studies is that by R. L. Kahn and D. Katz on "Leadership Practices in Relation to Productivity and Morale." This is Reading 41 in the above book.
43. Moreno, J. L., *Who Shall Survive? Foundations of Sociometry, Group Psychotherapy and Socio-Drama* (Rev. Ed.). Beacon House, 1953.
44. Gardner, E. F., and G. G. Thompson, *Social Relations and Morale in Small Groups*. Appleton-Century-Crofts, 1956.
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## Index of Names

Numbers below 543 refer to pages on which an author's contribution is discussed or on which his work is cited as a suggested reading. Numbers beginning with 543 refer to the page on which an author's contribution is identified and its source given.

- Adler, A., 159  
 Adolph, E. F., 144, 548  
 Aikman, L., 472, 571  
 Ailee, W. C., 461, 570  
 Allen, E. A., 145, 548  
 Allen, H. E., 402  
 Allport, F. H., 203, 404, 405, 429, 441, 442, 465, 484, 553, 566, 570, 572  
 Allport, G. W., 155, 161, 234, 248, 249, 252, 269, 481-483, 549, 550, 555, 556, 572  
 Alper, T. G., 226, 555  
 Alverdes, F., 462, 570  
 Amatrua, C. S., 85, 544  
 Amen, E. W., 198, 553  
 Ammons, C. H., 35, 543  
 Ammons, R. B., 298, 559  
 Anastasi, A., 58, 60, 73, 78, 90, 108, 109, 114, 118, 133, 136, 199, 269, 543, 544, 546, 547, 553  
 Anderson, A. C., 325, 562  
 Anderson, H. H., 364  
 Andrew, G., 352, 564  
 Andrews, T. G., 49  
 Angell, G. W., 299, 559  
 Anliker, J., 277  
 Antonitis, J. J., 153, 549  
 Arey, L. B., 66  
 Arieti, S., 260, 557  
 Asch, S. E., 478-480, 484, 572  
 Atkinson, J. W., 156, 219, 220, 232, 254, 550  
 Attneave, F., 444, 454  
 Austin, G. A., 355-357, 564  
 Ax, A. F., 185, 552  
 Axline, V. M., 267, 557  
 Azrin, N., 462, 570  
 Baar, J., 412, 567  
 Bach, G. R., 217, 218, 554  
 Bacon, F., 4  
 Bagby, E., 162, 550  
 Bair, J. H., 230, 555  
 Baker, C. T., 102, 103, 545  
 Baker, L., 221, 554  
 Baker, R. F., 66-67, 543  
 Bales, R. F., 470-472, 571  
 Barber, T. X., 320, 561  
 Barcroft, J., 229, 555  
 Bard, P., 187, 188, 552  
 Barker, M., 56, 543  
 Barker, R. G., 225, 554  
 Barron, F., 360, 564  
 Bartlett, F. C., 317, 318, 336, 344, 345, 364, 561, 563  
 Bartley, S. H., 414, 429, 567  
 Bash, K. W., 142, 547  
 Bavelas, A., 464, 472, 570, 571  
 Bayley, N., 86, 103, 104, 544, 545  
 Beach, F. A., 142, 146, 147, 173, 547, 548  
 Beardslee, D. C., 269, 429  
 Beaumont, H., 182, 551  
 Bechterev, V. M., 22, 273, 274, 557  
 Beck, L. F., 222, 423, 567  
 Beers, C., 262  
 Békésy, G. V., 381, 565  
 Bell, J. E., 246, 403, 546, 566  
 Benda, C. E., 99, 545  
 Benét, W. R., 361, 565  
 Bennett, G. K., 125, 126, 127, 546  
 Berkun, M. M., 143, 547  
 Berlyne, D. E., 152, 549  
 Berne, E. V., 56, 543  
 Berry, P. C., 472, 571  
 Bexton, W. H., 151, 173, 429, 549  
 Bijou, S. W., 228, 555  
 Bilodeau, E. A., 300, 301, 560  
 Bindra, D., 172, 443  
 Binet, A., 9, 84-89  
 Bingham, H. C., 147, 548  
 Bingham, W. V., 117, 546  
 Bird, C., 167, 551  
 Birney, R. C., 172  
 Birren, J. E., 104, 545  
 Bischof, L. J., 114  
 Blair, D., 266, 557  
 Blake, R. R., 429  
 Blatz, W. E., 183, 195, 551, 552  
 Block, C. H., 472, 571  
 Blommers, P., 542  
 Blum, M. L., 136  
 Boisen, A. T., 265  
 Bolles, M. M., 263, 266, 557  
 Bonner, H., 488  
 Booth, A. D., 444  
 Borgatta, E. F., 471, 571  
 Boring, E. C., 28, 55, 95, 101, 119, 182, 382, 414, 545, 551, 565, 567  
 Boveri, T., 69, 544  
 Bowers, A. M., 162  
 Bowman, P. H., 144, 548  
 Brady, D. M., 266, 557  
 Brady, J. V., 215, 216, 554  
 Brandt, H., 394, 395, 566  
 Brav, C. W., 382, 565  
 Brazier, M. A. B., 274, 276, 558  
 Breland, K., 282, 283, 558  
 Breland, M., 282, 283, 558  
 Bridges, K. M. B., 191, 192, 204, 552, 553  
 Briggs, G. E., 333, 562  
 Britt, S. H., 200, 553  
 Brogden, W. J., 276, 558  
 Bronner, A. F., 162

- Brothers, J., 333, 563  
 Brown, C. W., 49, 136  
 Brown, H. O., 350, 563  
 Brown, R., 449, 454, 569  
 Brown, R. W., 484  
 Brozek, J., 144, 548  
 Bruce, R. H., 297, 462, 559, 570  
 Bruner, J. S., 355-357, 404, 564, 566  
 Brunswik, E., 414, 567  
 Brush, E. S., 197, 553  
 Buchsbaum, R., 367  
 Buck, P., 101, 114, 545  
 Buckley, H., 420  
 Bugelski, B. R., 280, 308, 336, 558  
 Bühler, C., 195, 544, 553  
 Bunch, C. C., 381, 565  
 Bunch, M. E., 325, 562  
 Burchard, E. M. L., 237, 555  
 Burks, B. S., 96, 107, 108, 545, 546  
 Burton, A., 269  
 Burton, N. G., 447, 568  
 Buttt, H. E., 312, 561  
 Butler, R. A., 153, 549  
 Buxton, C., 297, 559  
  
 Calvin, A. D., 173  
 Cameron, N., 269  
 Cannon, W. B., 141, 142, 144, 177, 187, 547, 548, 551, 552  
 Cantril, H., 160, 177, 221, 429, 484, 485, 550, 551, 572  
 Carlson, A. J., 143, 547  
 Carmichael, L., 26, 78, 107, 156, 205, 324, 338, 385, 386, 403, 443, 543, 546, 549, 561, 563, 566, 568  
 Carpenter, C. R., 432, 567  
 Carr, H. A., 80, 544  
 Carroll, J. B., 364, 454, 455  
 Cartwright, D., 468, 472, 474, 488, 571  
 Cason, H., 182, 551  
 Cassirer, E., 435, 568  
 Cattell, J. McK., 9  
 Cattell, P., 544  
 Cattell, R. B., 234, 555  
 Cazzullo, C. L., 260, 557  
 Charcot, J. M., 16-17  
 Chase, S., 448, 569  
 Chave, E. J., 166, 550  
 Chen, S. C., 461, 570  
 Cherry, C., 432, 444, 445, 455, 568  
 Child, I. L., 160, 550  
 Chomsky, N., 443, 568  
 Christensen, P. R., 358, 364, 564  
 Church, J., 142, 548  
 Clark, R. A., 219, 220, 554  
 Cleckley, H., 257, 556  
 Cobb, S., 260  
 Coch, L., 476, 572  
 Cohen, E. A., 155, 549  
 Cohen, N., 199, 553  
 Coleman, J. C., 232  
 Coleman, J. D., 178-179  
 Combs, A. W., 209  
 Conant, J. B., 20, 49, 543  
 Cook, S. W., 228, 555  
 Cotton, J. W., 78  
 Cotzin, M., 35, 36, 543  
 Cowles, J. T., 280, 558  
  
 Cox, C. M., 95, 545  
 Crafts, L. W., 205, 324, 364, 562  
 Craig, W., 432, 458, 567, 569  
 Crawford, M. P., 433, 463, 568, 570  
 Cronbach, L. J., 114, 136, 269  
 Cruickshank, W. M., 97, 545  
 Crutchfield, R. S., 158, 550  
 Cruze, W. W., 241, 556  
 Culler, E. A., 274, 276, 558  
 Curtis, Q. F., 227, 555  
 Cutler, R. L., 400, 566  
  
 Dallenbach, K. M., 35, 36, 327, 328, 387, 543, 562, 565  
 D'Angelo, R. Y., 108, 109, 546  
 Daniel, R. S., 49, 78, 114, 172, 336, 344, 429, 563  
 Daniel, W. J., 462, 463, 570  
 Darrow, C. W., 182, 551  
 D'Arsonval, 9  
 Darwin, C., 9-11, 13, 177, 205, 226, 551  
 Dashiell, J. F., 192, 202, 350, 465, 553, 563, 570  
 David, E. E., Jr., 390, 455  
 Davis, H., 382, 425, 565, 567  
 Dees, V., 298, 559  
 Deese, J., 308, 331, 333, 562, 563  
 deHaan, J. A. B., 435, 568  
 DeLatil, P., 343, 563  
 Delgado, J. M. R., 188, 552  
 DeMartino, M. F., 161, 173, 550  
 Dember, H. C. B., 260  
 Dember, W. N., 429  
 Dembo, T., 160, 225, 550, 554  
 Dempsey, E. W., 142, 173, 547  
 Dennis, W., 28, 358, 564  
 Detwiler, S. R., 69, 544  
 DeValois, R. L., 269, 429  
 Dewey, J., 346  
 Dickens, C., 95  
 Dixon, W. J., 164, 550  
 Dollard, J., 291, 441, 558, 568  
 Doob, L. W., 486, 572  
 Dorcus, R. M., 163, 550  
 Dorkey, M., 197, 553  
 Droba, D. D., 166, 550  
 Drolette, M. E., 186, 552  
 DuBois, P. H., 123, 131, 546, 547  
 Dudycha, G. J., 310, 560  
 Dudycha, M. M., 310, 560  
 Duffy, E., 175, 551  
 Dulany, D. E., Jr., 151, 269, 364, 429, 549  
 Dunbar, F., 216  
 Duncan, C. P., 78, 331, 472, 562, 571  
 Duncker, K., 345  
 Dunn, C. C., 73, 74, 544  
 Dunn, W. H., 216, 554  
 Dvorak, B. J., 127, 547  
 Dymond, R. F., 259, 557  
 Dysinger, D. W., 184, 552  
  
 Eagan, E. P. F., 333, 563  
 Ebbinghaus, H., 7-8, 287, 323, 325, 333, 336, 562  
 Edwards, A. S., 82, 106, 429, 544, 545  
 Efron, D., 452, 569  
 Egan, J. P., 414, 567  
 Einstein, A., 95  
 Elliott, M. H., 297, 559  
 Ellis, W. D., 324, 411, 415, 562, 566, 567  
 Elwell, J. L., 298, 559  
 English, A. C., 481, 572

- English, H. B., 84, 481, 544, 572  
 Estabrooks, G. H., 163, 335, 550, 563  
 Evans, H. M., 66  
 Evans, R. M., 375, 565  
 Ewert, P. H., 350, 563  
  
 Farber, J. L., 199, 553  
 Farnsworth, P. R., 182, 551  
 Fechner, G. T., 6, 8  
 Fernald, G., 288  
 Ferster, C. B., 278, 279, 558  
 Festinger, L., 152, 153, 160, 549, 550  
 Fields, P. E., 80, 352, 544, 563  
 Finger, F. W., 228, 555  
 Fiske, D. W., 239, 244, 556  
 Fleishman, E. A., 131, 547  
 Fleming, A., 361  
 Flugel, J. C., 206  
 Foley, J. P., Jr., 60, 543  
 Ford, C. S., 147, 548  
 Foreman, S., 298, 559  
 Forlano, G., 302, 560  
 Fox, C., 104, 545  
 Frank, P., 95, 545  
 Franklin, B., 214  
 Franz, S. L., 393, 565-566  
 Frazer, J., 364  
 Fredericq, L., 141, 547  
 Freeman, F. N., 72, 544  
 Freeman, G. L., 396, 566  
 Freeman, L., 216  
 Freeman, W., 266, 557  
 French, J. R. P., 476, 572  
 Freud, S., 14, 17-18, 139, 154, 162, 179, 200,  
 203, 218, 219, 232, 250, 329, 338, 364, 547,  
 551, 554, 556, 562  
 Frink, H. W., 256, 556  
 Frisch, K. von, 432, 567  
 Fromm, E., 202, 553  
 Fulk, B. E., 108, 546  
 Fulton, J. F., 266, 557  
 Funkenstein, D. H., 186, 232, 552  
 Furness, W. H., 433, 568  
  
 Galambos, R., 36, 543  
 Galanter, E. H., 232, 410, 566  
 Galton, F., 8, 59  
 Gardiner, A. H., 448, 569  
 Gardner, E., 261, 390  
 Gardner, E. F., 469, 470, 571  
 Gardner, M., 334, 563  
 Garrett, H. E., 205  
 Garry, R., 308  
 Garth, T. R., 108, 110, 182, 546, 551  
 Gates, A. I., 302, 322, 323, 560, 561  
 Gauss, 348  
 Geldard, F. A., 378, 390, 565  
 Gellermann, L. W., 343, 563  
 Gerard, R. W., 311, 336, 561  
 Gesell, A., 14-15, 85, 544  
 Getzels, J. W., 167-170, 551  
 Chiselli, E. E., 49, 136  
 Gibb, C. A., 471, 571  
 Gibby, R. S., 114  
 Gibson, E. J., 418  
 Gibson, J. J., 416, 417, 420, 429, 567  
 Gibson, W., 155, 549  
 Gilbert, G. M., 221  
 Gillette, A. L., 323, 561  
  
 Gilliland, A. R., 544  
 Gilman, T. T., 178, 551  
 Gilmer, B. von H., 136, 205  
 Ginsburg, B. E., 75  
 Gladwin, T., 114  
 Glaser, N. M., 228, 555  
 Glenn, E. S., 448, 569  
 Glixman, A. G., 226, 555  
 Goethe, J. W., 95  
 Goetsch, W., 462, 570  
 Goldberg, L. R., 244, 556  
 Goldstein, K., 353-354, 564  
 Goodenough, F. L., 108, 114, 192, 193, 195, 417,  
 546, 552, 553, 567  
 Goodman, L. S., 350, 563  
 Goodnow, J. J., 355-357, 564  
 Gordon, H., 106, 545  
 Gordon, K., 393, 566  
 Gottschaldt, K., 409  
 Graham, C. H., 378, 565  
 Gray, G. W., 146, 548  
 Greene, R. W., 140, 547  
 Greenspoon, J., 281, 298, 558, 559  
 Grice, G. R., 297, 559  
 Griffin, D. R., 36, 543  
 Griffiths, W. J., Jr., 228, 555  
 Grindley, G. C., 298, 559  
 Grings, W. W., 49, 403, 566  
 Guetzkow, H. S., 144, 548  
 Guilford, J. P., 182, 234, 269, 358, 364, 551, 555,  
 564  
 Guillain, G., 17  
 Guthrie, E. R., 156, 254, 302, 303, 549, 556, 560  
  
 Hagman, E. R., 194, 552  
 Hall, C. S., 74, 218, 232, 269, 544  
 Hall, D. E., 148, 548  
 Hall, E. T., 452, 569  
 Hall, G. S., 14  
 Hall, J. F., 172  
 Hanfmann, E., 354  
 Harden, L. M., 331, 562  
 Hare, C., 75  
 Hare, P., 471, 571  
 Harlow, H. F., 101, 150, 153, 292, 293, 304, 314,  
 352, 364, 462, 545, 549, 558, 560, 561, 564,  
 570  
 Harrell, M. S., 118, 119, 546  
 Harrell, T. W., 108, 118, 119, 546  
 Harris, R. E., 269  
 Harsh, C. M., 239, 269, 556  
 Hart, G., 282, 558  
 Hartley, E. L., 114, 232, 364, 403, 404, 429,  
 470-476, 479, 480, 488, 566, 571, 572  
 Hartley, R. E., 114, 232, 364, 403, 429, 566  
 Hartline, H. K., 371  
 Hartman, C. G., 178, 551  
 Hartmann, G. W., 201, 553  
 Haskell, R. I., 295, 559  
 Hathaway, S. R., 247, 556  
 Hayakawa, S. I., 448, 449, 455, 569  
 Hayes, C., 293, 433, 558, 568  
 Hayes, K. J., 293, 433, 558, 568  
 Healy, W., 162, 288  
 Hebb, D. O., 83, 172, 302, 304, 327, 462, 544, 560,  
 562, 570  
 Hecht, S., 378, 565  
 Heidebreder, E., 352-353, 564  
 Helmholtz, H. v., 381

- Helson, H., 375, 429, 565  
 Henry, N. B., 114  
 Hepner, H. W., 136, 157, 550  
 Hering, E., 412  
 Hernández-Peón, R., 429  
 Heron, W., 151, 549  
 Heron, W. T., 163, 550  
 Herrick, C. J., 369  
 Herrstein, R. J., 281, 558  
 Hess, E. H., 458, 459, 569  
 Hess, W. R., 188, 552  
 Hicks, V. C., 80, 285, 544  
 Hilgard, E. R., 274, 295, 308, 364, 557, 559  
 Himwich, H. E., 262, 264, 265, 557  
 Hire, A. W., 269, 543  
 Hobbs, N., 299, 559  
 Hofstaetter, P. R., 86, 544  
 Hogan, H. F., 403, 566  
 Hollingworth, L. S., 97, 114, 545  
 Holmberg, A. R., 155, 549  
 Holt, E. B., 440, 568  
 Holzinger, K. J., 72, 544  
 Honzik, C. H., 297, 559  
 Hooker, D., 75  
 Hooker, H. F., 253, 556  
 Horn, C. A., 133, 134, 547  
 Horrocks, J. E., 239, 556  
 Hoskins, R. G., 146, 261, 548, 557  
 Houlihan, F. J., 332, 562  
 Houts, W. W., 319, 561  
 Howland, C. I., 302, 322, 560, 561  
 Howes, D. H., 404, 566  
 Howie, D., 405, 566  
 Hsia, Y., 378, 565  
 Huang, I., 358, 564  
 Hudgins, C. V., 230, 555  
 Hudson, B. B., 304, 560  
 Hull, C. L., 44, 163, 302-305, 355, 543, 550, 560, 564  
 Humphrey, G., 364  
 Hunt, J. McV., 155, 160, 209, 232, 549, 550, 554  
 Hunt, T., 200, 553  
 Hunt, W. A., 177, 551  
 Hunter, I. M. L., 310, 336, 561  
 Hunter, W. S., 230, 313, 342, 400, 436, 555, 561, 563, 566, 568  
 Husband, R. W., 80, 163, 544, 550  
 Hutchings, E., Jr., 429  
 Hutchinson, E. D., 360, 564  
 Hutt, M. L., 114  
 Huxley, J., 290  
  
 Isager, H., 201, 553  
 Immergluck, L., 403, 429, 566  
 Inbau, F. E., 182, 551  
 Ingalls, T. H., 99, 545  
 Inhelder, B., 364  
 Irion, A. L., 293, 302, 308, 329, 333, 336, 559, 560, 562, 563  
 Irwin, J. M., 333, 562  
 Irwin, O. C., 191, 552  
 Itard, J. M. G., 19  
  
 Jackson, D. D., 265, 557  
 Jacobson, E., 230, 349, 350, 555, 563  
 James, W., 161, 187, 205, 334, 355, 458, 550, 552, 563, 564, 569  
 Janet, P., 17  
 Jeffers, V. B., 375, 565  
  
 Jelliffe, S. E., 261  
 Jenkins, J. G., 327, 562  
 Jensen, D. W., 96, 545  
 Jersild, A. T., 196, 197, 205, 553  
 Jersild, C. L., 196, 197, 553  
 Jespersen, O., 436, 568  
 Johns, W. B., 296, 559  
 Johnson, B., 432, 567  
 Johnson, D. M., 364  
 Johnson, V., 143, 543  
 Jones, H. E., 47, 107, 194, 253, 543, 546, 552, 556  
 Jones, L., 106, 545  
 Jones, M. C., 194, 552  
 Jones, M. R., 142, 152, 153, 156, 172, 197, 304, 547, 549, 550, 553, 560  
 Jourard, S. M., 202, 553  
 Judd, C. H., 295, 436, 559, 568  
 Jung, C. G., 235, 555  
  
 Kahn, R. L., 468, 571  
 Kallman, F. J., 260, 557  
 Kalmus, H., 432, 567  
 Kamin, L. J., 276, 558  
 Kappauf, W. E., 414, 567  
 Karn, H. W., 136  
 Karnosh, L. J., 260, 557  
 Karpman, B., 219, 554  
 Kananin, J., 354  
 Katona, G., 294, 326, 559, 562  
 Katz, B., 370  
 Katz, Daniel, 460, 468, 570, 571  
 Katz, David, 375, 565  
 Kees, W., 451, 569  
 Keller, F. S., 28  
 Keller, H., 435, 568  
 Kelley, H. H., 472, 488, 571  
 Kellogg, W. N., 274, 303, 557, 560  
 Kelly, E. L., 244, 556  
 Kemp, S. H., 382, 565  
 Kessen, M. L., 143, 547, 548  
 Kettner, N. W., 358, 564  
 Key, C. B., 106, 545  
 Keys, A., 144, 239, 548, 556  
 Killian, L. M., 465, 488, 570  
 Kimble, G. A., 49, 64, 300, 301, 543, 560  
 Kinder, E. F., 140, 547  
 King, G., 444, 447, 568, 569  
 King, G. F., 246, 556  
 King, S. H., 186, 552  
 Kingsley, H. L., 308  
 Kinsey, A. C., 146, 464, 548, 570  
 Kish, G. B., 153, 549  
 Kitson, H. D., 164, 550  
 Klapman, J. W., 259, 557  
 Klee, J. B., 228, 555  
 Klineberg, O., 108, 172, 194, 546, 552  
 Kluckhohn, C., 149, 252, 548, 556  
 Klüver, H., 320, 351, 561, 563  
 Knight, J., 216  
 Kobler, J., 449, 569  
 Koffka, K., 24, 429  
 Köhler, W., 24-25, 290, 415, 429, 558, 567  
 Kohn, M., 143, 547  
 Korzybski, A., 449, 560  
 Krech, D., 158, 550  
 Kretschmer, E., 237  
 Krogh, A., 432, 567  
 Krueger, W. C. F., 323, 324, 561  
 Kube, E., 232

- Kuder, G. F., 120, 121, 546  
 Kuenne, M., 293, 558  
 Kutner, B., 166, 550  
 Lamoreaux, R. R., 197, 553  
 Landis, C., 181, 263, 266, 557  
 Landreth, C., 198, 206, 553  
 Langer, S. K., 435, 436, 568  
 Langfeld, H. S., 55, 382, 414, 565, 567  
 Lashley, K. S., 227, 302, 560  
 Lasswell, H. W., 221  
 Lathan, C., 80, 544  
 Leahy, A. M., 107, 108, 546  
 Leavitt, H. J., 312, 473, 561, 571  
 LeBon, G., 483, 572  
 Lee, E. S., 109, 546  
 Lee, H. W., 358, 564  
 Leeper, R. W., 177, 364, 429, 466, 551, 571  
 Lehman, H. C., 358  
 Lehner, G. F. J., 232  
 Leonard, W. E., 162, 550  
 Leuba, C., 429, 462, 570  
 Levin, H., 251, 556  
 Levine, J., 200, 553  
 Levy, D., 149, 548  
 Lewin, K., 160, 209, 225, 249, 466-468, 474-476, 488, 550, 554, 556, 570, 571, 572  
 Lewis, D., 286, 558  
 Lewis, M. M., 455  
 Li, C. H., 146, 548  
 Licklider, J. R. C., 443, 447, 568  
 Liddell, H. S., 273  
 Lilly, J. C., 152, 549  
 Lindquist, E. F., 542  
 Lindsley, D. B., 184, 185, 187, 206, 230, 551, 555  
 Lindsley, O. R., 462, 570  
 Lindzey, G., 206, 248, 269, 462, 464, 484, 488, 556, 570  
 Lipman, E. A., 276, 558  
 Lippitt, R., 474, 571  
 Livingston, W. K., 369  
 Locke, J., 19  
 Locke, W. N., 444  
 Long, L., 352, 564  
 Looney, E., 188, 552  
 Lorenz, K., 432, 457, 458, 567, 569  
 Lorge, I., 92, 472, 544, 571  
 Lowell, E. L., 219, 220, 554  
 Luchins, A., 349, 563  
 Luckhardt, A. B., 143, 547  
 Lund, F. H., 184, 552  
 Maccoby, E. E., 251, 404, 470-476, 479, 480, 488, 556, 566, 571, 572  
 Macpherson, S. J., 298, 559  
 Magaret, A., 269  
 Magoun, H. W., 188, 552  
 Magsdick, W. K., 325, 562  
 Maier, N. R. F., 136, 209, 210, 212, 213, 227, 228, 339, 340, 348, 464, 469, 554, 555, 563, 570  
 Marcuse, F. L., 172, 178, 551  
 Markey, F. V., 196, 197, 553  
 Marquart, D. I., 472, 571  
 Marquis, D. G., 61, 111, 274, 557  
 Marston, L. R., 235, 555  
 Martin, C. E., 146, 464, 548, 570  
 Marx, M. H., 429  
 Masland, R. L., 114  
 Maslow, A. H., 155, 314, 549, 561  
 Masserman, J. H., 188, 552  
 Maurois, A., 361-362, 565  
 Max, L. W., 230, 349, 555, 563  
 Maxick, 230, 555  
 May, M. A., 197, 553  
 Mayer, J., 277  
 Maze, J. R., 142, 547  
 McCarthy, D., 442, 568  
 McClearn, G. E., 153, 549  
 McClelland, D., 219, 220, 554  
 McClelland, D. C., 156, 173, 180, 181, 549, 551  
 McConnell, J. V., 400, 566  
 McCormick, E. J., 136  
 McCurdy, H. S., 95, 184, 552  
 McDougall, W., 203, 483, 553, 572  
 McElwee, E. W., 316, 561  
 McFann, H. H., 199, 553  
 McFarland, R. A., 136  
 McGeech, J. A., 293, 302, 308, 311, 329, 333, 336, 559-563  
 McGinnies, E., 404, 566  
 McGraw, M. B., 45, 543  
 McGuigan, F. J., 173  
 McKell, T. E., 215, 554  
 McKinley, J. C., 247, 556  
 McNeil, E. B., 400, 566  
 McNemar, Q., 106, 546  
 Mead, M., 156, 157, 358, 550, 564  
 Meadow, A., 472  
 Mees, C. E. K., 4, 543  
 Meier, N. C., 132, 133, 547  
 Melton, A. W., 136, 311, 333, 561, 562  
 Meltzer, H., 199, 553  
 Menninger, K., 146, 255, 548, 556  
 Menzies, R., 230, 555  
 Merrill, M. A., 86, 114, 544  
 Merryman, J. G., 402  
 Mesmer, F. A., 16  
 Miles, G. H., 286, 558  
 Mill, J. S., 95  
 Miller, D. S., 75  
 Miller, G. A., 232, 343, 344, 446, 455, 563  
 Miller, N. E., 143, 197, 209, 232, 282, 291, 441, 547, 548, 553, 554, 558, 568  
 Millichamp, D. A., 195, 552  
 Milner, P., 188, 552  
 Minami, H., 327, 328, 562  
 Miner, J. B., 108, 110, 546  
 Mirsky, A. E., 66, 543  
 Mohr, C. J., 148, 548  
 Montagu, A., 149, 548  
 Montgomery, K. C., 153, 281, 549, 558  
 Moore, A. V., 178, 551  
 Moore, J. E., 182, 551  
 Moreno, J. L., 259, 468, 557, 571  
 Morgan, C. T., 142, 143, 381, 547  
 Morgan, J. D., 142, 547  
 Morgan, J. J. B., 191, 396, 552, 566  
 Morse, W. H., 281, 558  
 Moskowitz, M. J., 140, 141, 547  
 Moss, F. A., 200, 553  
 Moss, G., 472, 571  
 Moustakas, C. E., 267, 557  
 Mowrer, O. H., 197, 224, 225, 308, 440, 462, 553, 554, 568, 570  
 Mullahy, P., 203, 553  
 Müller, J., 366, 565  
 Munn, N. L., 78, 148, 155, 156, 173, 192, 276, 283, 289, 297, 301, 305, 314, 320, 324, 331, 351,

- 352, 437, 442, 443, 548, 549, 552, 558-562, 564, 568
- Münsterberg, H., 319
- Murchison, C., 144, 187, 209, 253, 320, 460, 465, 548, 552, 554, 556, 561, 569, 570
- Murphy, G., 28, 258, 556
- Murray, H. A., 149, 246, 252, 548, 556
- Nagge, J. W., 342, 563
- Neet, C. C., 352, 564
- Neff, W. S., 106, 546
- Nelson, V. L., 102, 103, 545
- Netter, F., 257
- Newcomb, T. M., 470-476, 479, 480, 488, 571, 572
- Newman, H. H., 72, 544
- Newman, J. R., 359
- Neymann, C. A., 236, 555
- Nice, M. M., 442, 568
- Nissen, H. W., 147, 153, 548, 549
- Nowlis, H., 175, 551
- Nowlis, V., 175, 551
- Nutt, R. H., 333, 563
- Nygaard, P. H., 64, 543
- Odbert, H. S., 234, 555
- Oden, M. H., 96, 114, 545
- Ogden, C. K., 449, 569
- Okarski, J. F., 246, 556
- Olds, J., 173, 188, 552
- Omwake, K. T., 200, 553
- O'Neil, W. M., 49, 366, 565
- Orlansky, H., 150, 548
- Osborn, A. F., 472, 571
- Osgood, C. E., 417, 449, 450, 454, 569
- Packard, V., 400, 464
- Parker, G. H., 368
- Parnell, R. W., 237, 239, 556
- Parnes, S. J., 472
- Paschal, F. C., 393, 565
- Pastore, N., 260, 557
- Paterson, D. G., 122, 546
- Patrick, C., 360, 564
- Patrick, J. R., 224, 554
- Pavlov, I., 22-23, 226, 271-274, 276, 280, 302, 303, 310, 555, 557
- Pease, D. C., 66-67, 543
- Penfield, W., 329, 330, 374, 435, 455, 562, 565, 568
- Perin, C. T., 297, 559
- Peters, R. S., 28
- Peterson, J., 84, 85, 484, 544, 572
- Pfeiffer, J., 390
- Piaget, J., 358, 364, 564
- Pierce, J. R., 390, 455
- Piéron, H., 393, 565
- Pinneau, S. R., 150, 548
- Podell, H. A., 355, 564
- Poincaré, H., 359, 360
- Pollock, L., 443
- Pomeroy, W. B., 146, 464, 548, 570
- Porter, P. B., 331, 562
- Postman, L., 325, 326, 404, 414, 481-483, 562, 566, 567, 572
- Pressey, S. L., 114
- Preston, G. H., 407, 566
- Preyer, W., 13-14
- Pribram, K. H., 232
- Quastler, H., 444
- Quigley, J. P., 143, 547
- Radler, D. H., 167, 168, 551
- Rapp, A., 200, 553
- Rasmussen, E. W., 462, 570
- Rasmussen, T., 374, 565
- Ratoosh, P., 419, 567
- Rau, L., 325, 326, 562
- Raynor, R., 195, 552
- Razran, G. H., 23, 274, 558
- Reed, R., 148, 548
- Remmers, H. H., 167, 168, 551
- Reymert, M. L., 184, 206, 551
- Ribble, M., 149, 548
- Richards, I. A., 182, 449, 551, 569
- Richardson, J., 301, 326, 560, 562
- Richter, C. P., 145
- Riesen, A. H., 406, 566
- Rignano, E., 347, 553
- Rinkel, M., 260
- Riopelle, A. J., 293, 558
- Riviere, J., 219, 554
- Roberts, K. E., 294, 559
- Roberts, L., 435, 455, 568
- Robinson, M. F., 266, 557
- Roby, T. B., 304, 560
- Roethlisberger, F. J., 164, 550
- Rogers, C., 258, 259, 557
- Rohrer, J. H., 110, 546
- Root, A. R., 236, 555
- Rorschach, H., 245-246
- Rosenblith, W. A., 381, 565
- Rosenzweig, P., 226, 554
- Rosenzweig, S., 212, 554
- Rosvold, H. E., 188, 552
- Rotter, J. B., 159-160
- Rowley, J. B., 415, 567
- Royce, J., 49
- Ruesch, J., 451, 569
- Russell, R. W., 358, 564
- Ryan, T. A., 136
- Sarason, S. B., 114
- Sarbin, T. R., 464, 570
- Sargent, S. S., 167, 464, 485, 551, 570, 572
- Sassaman, W. H., 230, 555
- Sawrey, W. L., 215, 554
- Schachter, S., 173
- Schaie, K. W., 104, 105, 545
- Scheerer, M., 353-354, 564
- Schein, E. H., 480, 572
- Schjelderup-Ebbe, T., 460, 569
- Schlossberg, H., 173, 175, 179, 189, 206, 301, 308, 310, 312, 331, 336, 364, 390, 410, 421, 429, 551, 552, 560-562, 566, 567
- Schneider, D. M., 252, 556
- Schrackel, H. G., 239, 269, 556
- Scott, J. P., 173, 199, 457, 458, 460, 461, 488, 553, 569, 570
- Scott, T. H., 151, 549
- Scripture, E. W., 409, 566
- Sears, P. S., 160, 550
- Sears, R. R., 222, 245, 251, 554, 556
- Seashore, C. E., 132, 547
- Seashore, H. G., 125-127, 546
- Segall, M., 153, 549
- Seidman, J. M., 544
- Selfridge, J. A., 446
- Selye, H., 214, 215, 232, 554

- Senders, V. L., 78  
Shaffer, L. F., 182, 267, 269, 551, 557  
Shannon, C. E., 444, 568  
Shaw, M. E., 472, 571  
Sheard, N. M., 148, 548  
Sheffield, F. D., 304, 560  
Sheldon, W. H., 237-239, 555  
Shepard, W., 293, 559  
Sherif, C. W., 477, 478, 572  
Sherif, M., 160, 182, 477, 478 550, 551, 572  
Sherman, I. C., 191, 552  
Sherman, M., 106, 191, 545, 552  
Shirley, M. M., 249, 556  
Shoben, E. J., Jr., 267, 269, 557  
Simon, T., 84-85  
Sinnott, E. W., 74  
Skalet, M., 314, 561  
Skinner, B. F., 276-280, 282, 283, 403, 437, 440, 442, 455, 558, 566, 568  
Sladen, W. J. L., 35  
Sleight, W. G., 294, 559  
Smith, K. U., 352, 414, 564, 567  
Smith, L. F., 133, 134, 547  
Smith, M. E., 442, 568  
Smith, P. C., 136  
Smith, S., 156, 549  
Smith, S. M., 350, 563  
Smode, A. F., 298, 299, 559  
Snow, W. B., 525, 567  
Snygg, D., 209  
Solomon, E. E., 143, 547  
Solomon, R. L., 197, 276, 404, 553, 558, 566  
Sontag, L. W., 102, 103, 545  
Spatz, D., 199, 553  
Spearman, C., 94, 545  
Spence, K. W., 199, 553  
Sperling, H. G., 478, 572  
Spiegel, J., 472, 571  
Spitz, R. A., 195, 553  
Spoonster, A., 274, 303, 557, 560  
Spragg, S. D., 433, 568  
Spranger, E., 248, 556  
Sprott, W. J. H., 488  
Stacey, C. L., 161, 173, 550  
Starr, A. S., 316, 561  
Steichen, E., 452, 569  
Steinberg, J. C., 425, 567  
Steining, B. R., 352, 564  
Stellar, E., 143, 547  
Stern, W., 85, 544  
Stevens, S. S., 53-55, 142, 173, 184, 197, 206, 237, 238, 364, 381, 382, 390, 394, 410, 414, 425, 543, 547, 553, 555, 565-567  
Stewart, N., 118, 546  
Stolurow, L. M., 303, 560  
Stone, C. P., 140, 145, 147, 331, 547, 548, 562  
Stone, L. J., 150, 548  
Strang, R., 97, 545  
Strong, E. K., 120, 165, 546, 550  
Stroud, J. B., 295, 559  
Sturman-Hulbe, M., 140, 547  
Suci, G. J., 448, 450, 455, 569  
Sullivan, A. J., 215, 554  
Supa, M., 35, 36, 543  
Swezy, D., 66  
Szasz, S., 206  
Taylor, D. W., 300, 472, 560, 571  
Taylor, J. A., 78, 199, 553  
Taylor, J. H., 191, 552  
Teagarden, F. M., 147, 548  
Teevan, R. C., 172  
Temple, R., 198, 553  
Templeton, R. D., 143, 547  
Terman, L. M., 31, 86, 89, 95-97, 114, 544, 545  
Thibaut, J. W., 472, 488, 571  
Thigpen, C. H., 257, 556  
Thompson, G. G., 196, 469, 470, 571  
Thompson, J., 193, 552  
Thompson, R., 293, 558  
Thompson, S. P., 412  
Thompson, W. R., 462, 570  
Thoreau, H., 178  
Thorndike, E. L., 53, 277, 295, 305, 435-437, 543, 558-560, 568  
Thorndike, R. L., 92, 544  
Thorpe, L. P., 241, 556  
Thorpe, W. H., 432, 567  
Thouless, R. H., 414, 567  
Thrasher, F. M., 461, 570  
Thruelsen, R., 449, 569  
Thurstone, L. L., 54, 94, 105, 117, 166, 234, 246, 543, 545, 550, 555, 556  
Thurstone, T. G., 94, 545  
Tiffin, J., 136  
Tighe, T. J., 418  
Tinbergen, N., 36, 37, 543  
Tinklepaugh, O. L., 314, 561  
Titchener, E. B., 12, 543  
Toll, A., 460, 570  
Tolman, E. C., 297, 302, 303, 364, 559, 560  
Toman, J. E. P., 350, 563  
Tomkins, S. S., 215, 216, 554  
Totten, E., 350, 563  
Tower, D. B., 101, 545  
Townsend, J. C., 49  
Travis, R. C., 300, 560  
Tredgold, A. F., 99  
Triplett, N., 466, 570  
Tryon, R. C., 74, 75, 76, 544  
Tsai, C. A., 312, 561  
Tsang, Y. C., 142, 547  
Tucker, W. B., 237, 555  
Tuckman, J., 472, 571  
Turner, R. H., 488  
Twitchell-Allen, D., 403, 566  
Tyler, L. E., 78, 106, 546  
Uhling, H., 314, 561  
Ulmer, G., 295, 559  
Underwood, B. J., 49, 78, 301, 323, 326, 560-562  
Valentine, W. L., 49, 106, 163, 545, 550  
Van Dusen, F., 312, 561  
Van Tilborg, P. W., 311, 561  
Vernon, M. D., 429  
Vernon, P. E., 248, 556  
Verplanck, W. S., 281, 558  
Vinacke, W. A., 49, 364  
Viteles, M., 164, 550  
Voeks, V. W., 303, 560  
von Lackum, W. J., 333, 562  
Waldfoegel, S., 310, 561  
Walk, R. D., 418  
Wallas, G., 360, 564  
Tannenbaum, P. H., 449, 450, 569  
Tarde, G., 484, 572

- Wallin, J. E. W., 99, 545  
 Walpole, H., 361  
 Walsh, E. C., 390  
 Walsh, J. J., 167–170, 551  
 Walter, A. A., 403, 566  
 Walter, H. E., 69, 544  
 Wang, G. H., 140, 547  
 Wapner, S., 426, 567  
 Ward, L. B., 293, 324, 559  
 Warden, C. J., 412, 415, 566, 567  
 Warren, H. C., 156, 338, 385, 386, 549, 563  
 Washburn, R. W., 200, 553  
 Watson, G., 201, 553  
 Watson, J. B., 21–24, 191, 195, 196, 441, 552, 568  
 Watts, J. W., 266, 557  
 Weaver, W., 29–30, 444, 446, 447, 543, 568  
 Webb, W. B., 175, 551  
 Weber, E. H., 6, 8, 409–410  
 Wechsler, D., 89, 96, 104, 114, 544, 545  
 Weinberg, H., 269, 543  
 Weinland, J. D., 333, 336, 563  
 Weinstein, B., 314, 561  
 Weisz, J. D., 215, 554  
 Welch, L., 352, 564  
 Weld, H. P., 55, 382, 414, 565, 567  
 Welker, W. I., 153, 549  
 Welty, J. C., 461, 570  
 Wenzel, B. M., 385  
 Wertheimer, Max, 24, 343, 348, 349, 364, 411, 413, 563, 566, 567  
 Wertheimer, Michael, 364, 405, 566  
 Wesman, A. G., 125, 126, 127, 546  
 Wever, E. C., 382, 565  
 Wheeler, L. R., 106, 545  
 Wheeler, R. H., 100, 545  
 Wheeler, W. M., 462, 570  
 White, R. K., 474, 475, 571  
 White, R. W., 269, 329, 331, 562  
 White, W. A., 261  
 Whiting, J. W. M., 160, 550  
 Whorf, B. L., 364, 431, 448, 455, 567, 569  
 Whyte, W. F., 461, 570  
 Wickens, D. D., 106, 163, 545, 550  
 Wiesner, B. P., 148, 548  
 Williamson, R. C., 167, 464, 485, 551, 570, 572  
 Winchester, A. M., 70, 78, 544  
 Winslow, C. N., 412, 566  
 Winterbottom, M. R., 156, 269, 429, 550  
 Witkin, H. A., 41, 426, 567  
 Witmer, L., 19  
 Witt, G., 74, 544  
 Wittenborn, J. R., 85, 544  
 Witty, P., 545  
 Wolf, A. W. M., 206  
 Wolf, S., 184, 215, 552, 554  
 Wolfe, J. B., 280, 281, 297, 558, 559  
 Wolff, H. G., 184, 215, 552, 554  
 Wolffe, D. L., 463, 570  
 Wolffe, H. M., 274, 463, 557, 570  
 Woodrow, H., 334, 563  
 Woodworth, R. S., 28, 61, 111, 161, 173, 175, 189, 206, 258, 295, 301, 308, 310, 331, 336, 355, 364, 390, 410, 421, 429, 544, 550–552, 557, 559–562, 564, 566, 567  
 Woolsey, C. N., 101, 545  
 Worrell, P., 35, 543  
 Wright, S. T. H., 300, 560  
 Wundt, W., 6–9, 21  
 Wynne, L. C., 276, 558  
 Yacorzynski, G. K., 236, 302, 555, 560  
 Yerkes, R. M., 92, 340, 341, 432, 544, 563, 567  
 Yoakum, C. S., 92, 544  
 Young, K., 461, 570  
 Young, P. T., 182, 214, 297, 336, 425, 551, 554, 559, 567  
 Zander, A., 468, 472, 474, 488, 571  
 Zeigarnik, B., 226, 324, 554, 562  
 Zöllner, F., 412  
 Zucker, E. M., 260, 557  
 Zuckerman, S., 290



## Index of Subjects

- Ability (*see* Aptitude; Intelligence)  
 Abnormality, 15-19, 70-71  
 Abnormal psychology, 15-19, 98-103, 251, 255-256  
 Abscissa, 57-58  
 Absolute refractory period, 370  
 Absolute units, 53  
 Abstracting, 351-358  
 Accommodation, 376, 421  
 Achievement imagery, 219-220  
 Achievement motive, 156-157, 219-220  
 Achromatic vision, 375  
 Acquired behavior (*see* Habits; Learning)  
 Acquired motives, 154-160  
 Acquisition curve, 278-279  
 ACTH, 240-241  
 Action current, 369  
 Activity cage, 140-141, 145  
 Adaptation, dark and light, 378  
 Adrenal glands, 239-241  
 Adrenalin, 240-241  
 Affection, 192, 201, 202; need for, 149-151  
 Affective processes in perceiving, 401-402  
 Affects, 178 (*see also* Emotion)  
 Afferent nerve fiber, 371  
 Afferent neuron, 368  
 AFQT, 92  
 AGCT, 92, 118-119  
 Aggression, 199; fantasy, 217-218; from frustration, 213  
 Aggressiveness, 157  
 Alarm reaction, 214  
 Alcoholic psychoses, 262  
 All-or-nothing principle, 370, 378  
 Allport-Vernon-Lindzey Study of Values, 248  
 Alternatives in conflicts, 209-211  
 Ambivalence, 211  
 Ambiversion, 236  
 Amnesia, 257  
 Amoeba, 366-367  
 Amplitude, 379  
 Ampulla, 383  
 Anaglyphs, 422  
 Androgens, 145  
 Anechoic chamber, 43  
 Anger, 192, 199  
 Animal psychology, 10-13, 34-37, 73-76, 79-80  
 Animals: communication, 432-436; reasoning, 339-343; in research, 13  
 Animism, 358  
 Anterograde amnesia, 326  
 Anticipation, 181  
 Anticipation method, 316  
 Anvil, 379, 380  
 Anxiety, 197-199 (*see also* Conflict; Stress)  
 Anxiety neuroses, 257-258  
 Aphasia, 375  
 Apparent motion, 412-414  
 Apperception, 246  
 Approach-approach conflict, 209-210  
 Approach-avoidance conflict, 211  
 Aptitude, 115-136, 236; artistic, 132-133; factors, 124; and general intelligence, 117-119; and interests, 119-122; nature and origin, 116-117; patterns, 127; tests, 54, 122-133  
 Aqueous humor, 376  
 Armed Forces Qualification Test (AFQT), 92  
 Army Alpha intelligence test, 92  
 Army Beta intelligence test, 92  
 Army General Classification Test (AGCT), 92, 118-119  
 Artistic aptitude, 132-133  
 Aspiration levels, 159-160  
 Assimilation, 483  
 Association areas, 374-375  
 Association neuron, 369  
 Associative functions, 373  
 Associative reflex, 273  
 Associative strength, 310, 316, 323, 326  
 Astereognosis, 375  
 Asthenic physique, 237  
 Athletic physique, 237  
 Attending, 391-400; central control, 397; determiners, 398-400; perceiving and, 392; postural adjustment, 393, 395-396; receptor adjustment, 393-395; and set, 392-393; value, 394; varieties, 398  
 Attitude, 164-170 (*see also* Set)  
 Audiogenic seizures, 74-75  
 Auditory canal, 379  
 Auditory localization, 423-425  
 Auditory nerve, 379, 383  
 Auditory reception, 379-382  
 Auditory space perception, 423-425  
 Authoritarian leadership, 474-475  
 Autocorrectivism, 216  
 Autokinetic effect, 477-478  
 Autonomic nervous system, 189-190  
 Average (*see* Mean)  
 Avoidance-avoidance conflict, 210-211  
 Avoidance conditioning, 276  
 Avoidance motive, 181  
 Axon, 368  
 Babbling, 435-437, 440-441  
 Backward conditioning, 274  
 Bard-Cannon theory of emotion, 187  
 Bar graph, 59  
 Barriers, 207-209  
 Basal age, 88  
 Basilar membrane, 380-381  
 Bees, communication, 432  
 Behaviorism, 21-24  
 Behavior tests, 243  
 Belittling others, 221  
 Bennett, Seashore, and Wesman Mechanical Reasoning Test, 122  
 Berkeley Growth Study, 103, 104  
 Bimodal curve, 60

- Binary digit, 444
- Binet-Simon intelligence tests, 84-85
- Biological memory, 309
- Birth order, 253
- Bit, 444-445
- Blaming others, 221
- Blind, obstacle perception, 35-36
- Blind spot, 376
- Brain, 82-83, 371-375
- Brain stem, 187, 371-373
- Brainstorming, 472
- "Brain-washing," 480-481
- Brain waves, 184
- Brightness, 375, 378
- Candle-blowing problem, 348
- Case history, 32-33, 242
- Catatonic schizophrenia, 264
- Cell multiplication, 67-69
- Central control in attending, 397
- Central nervous system, 187, 367; mechanisms, 371-375 (*see also* Brain; Cerebral cortex; Spinal cord)
- Central-peripheral theory of thinking, 350
- Central tendency, measures, 537-538
- Central theory of thinking, 349-350
- Cerebellum, 371-373
- Cerebral cortex, 187-189, 371-375, 397
- Cerebral hemispheres, 371
- Cerebrotonia, 238
- Cerebrum, 187-189, 371-375, 397
- Character, 235
- Child psychology, 13-15, 32-34; gifted child, 94-98
- Chimpanzees, communication, 432-435
- Chlorpromazine, 260, 266
- Choroid coat, 376
- Chromatic vision, 375-378
- Chromosomes, 65-67
- Chronological age (C.A.), 85
- Chronoscope, 9
- Ciliary muscle, 376
- Circuits, 373
- Circumvallate papillae, 385
- Classical conditioning, 274, 304
- Class intervals, 57-59
- Clerical aptitude, 122
- Client-centered therapy, 258-259
- Clinical psychology, 15, 19-20, 32
- Cochlea, 379-381
- Cochlear branch, 379
- Cochlear canal, 380
- Coefficient of correlation, 47, 63-65, 541
- Coenotrope, 156
- Collective problem-solving, 471-473
- Color blindness, 376-378
- Color vision, 375-378
- Communication, 430-455; animal, 432-436; networks, 473; nonverbal, 450-453; process, 443-447
- Compensation, 216-217
- Compensatory tracking, 286, 299
- Competition, 461-463
- Complex coordinator, 286
- Computer, 343-344
- Concept, 350-358
- Concept Mastery Test, 96
- Conditional reflex, 272
- Conditional stimulus, 272
- Conditioned reflex, 22-23, 271-272
- Conditioned response, 271-272 (*see also* Conditioning)
- Conditioning, 271-283; classical, 272-274; instrumental, 274, 276-283; operant, 274, 276-283; sequence and time relation, 274
- Cones, 375-377
- Configurationalist psychology, 25
- Conflict, 207-232; consequence, 214-216; experimental, 226-228; indirect reactions to, 216-226; involving alternatives, 209-211
- Conformity, 170, 477-481
- Connector neuron, 369
- Conscience, 250 (*see also* Superego)
- Consciousness, 11-12
- Constancy phenomenon, 414-415
- Contiguity in learning, 303
- Control condition, 40-43
- Control group, 45-46
- Convergence, 421
- Cooperation, 461-463
- Cornea, 376
- Correlation, 47, 55-56, 62-65, 541-542
- Cortisone, 240-241
- Cortone, 241
- Co-twin control, 45
- Counterbalancing, 42-43
- Covert response, 39
- Cranial nerves, 372
- Creative thinking, 358-362
- Cretinism, 100
- Crista, 383
- Critical ratio (CR), 541
- Cross-sectional studies, 103
- Crowd behavior, 483-485
- Cytoplasm, 65-66, 69
- Dark adaptation, 378
- Déjà vu* experience, 321
- Delayed reaction, 312-315
- Delight, 192
- Delirium tremens, 262
- Delusions, 260, 346
- Dementia praecox, 263
- Democratic leadership, 474-475
- Dendrites, 368
- Dependent variable, 40, 46
- Depression, 262
- Depth perception, 415-423
- Depth traits, 234
- Detour problems, 289
- Developmental psychology, 31-32
- Developmental schedules, 14
- Deviation, 538
- Deviation I.Q., 88
- Differences: perceiving, 409-410; reliability, 47, 451
- Differential Aptitude Test (DAT), 125-127
- Differential conditioning, 275
- Direction perception, 423-425
- Direction in reasoning 346-349
- Discrimination: apparatus, 10-11; learning curves, 293; relational, 415; threshold, 409
- Disgust, 192
- Displacement, 258
- Dissociation, 256-257
- Dissociation principle, 355
- Distance perception, 415-423
- Distress, 192
- Distributed learning, 299-302, 321-322

- Distribution, 538–539; of individual differences, 57–61
- Dominance hierarchy, 460–461
- Dominant gene, 73
- Dorsal root, 371
- Double alternation problems, 341–343
- Doubt, 255–256
- Dreams, 218–219, 338; analysis, 258
- Drives, physiological, 138–141
- Drive state, 140
- Dual personality, 257
- Dynamometer, 53
- Ear, 379–381
- Eardrum, 379, 380
- Ectomorphy, 237–238
- Educational psychology, 8
- Education of the gifted, 97–98
- Efferent nerve fiber, 371
- Efferent neuron, 368
- Effort, 164
- Ego, 139, 162, 250
- Ego-defensive reactions, 216–217
- Ego-involvements, 160
- Eidetic imagery, 319–320
- Elation, 192
- Electra complex, 203
- Electroconvulsive shock (ECS), 330–331
- Electroconvulsive therapy (ECT), 262, 266
- Electroencephalogram (EEG), 184
- Emotions: development, 191–195; as energy source, 177–178; evolution of, 177; and feeling, 178–186; as function of whole organism, 186–190; and motivation, 174–206; physiology, 182–186
- Endocrine glands, and personality, 239–242
- Endolymph, 383
- Endomorph, 237–238
- Engram, 310–311
- Environment, 69–76, 105–108; control of, 40–43; effect on intelligence, 83–84, 110–112
- Equivalent groups, 45
- Escape from conflict, 216
- Escape training, 278, 282
- Estrogens, 145–146
- Eustachian tube, 379
- Evolution, 9–13
- Excitement in infants, 191–192
- Exercise in learning, 305
- Exhaustion in stress, 214
- Experience, and meaning, 405–407
- Experimental condition, 40–43
- Experimental groups, 45–46
- Experimental introspection, 7
- Experimental neurosis, 226–228
- Experimentation, 34–46
- Explicit responses, 39
- Exploration need, 152–154
- External environments, 70
- External stimuli, 38
- Extinction of conditioned response, 275, 279–280
- Extraversion, 235–236
- Eye, 375–377; movements, 394–395
- Eye-hand coordination, 123–124, 286
- Facial vision, 35–36
- Facilitation, 461–462
- False recognition, 321
- Fantasy, 217–221, 338
- Fear, 191, 192, 196–197
- Feeble-mindedness, 18–19, 70, 71, 98–103
- Feeling and emotion, 178–186
- Fels growth study, 102–103
- Fertilization, 69
- Finger dexterity test, 123
- Fixation, 228
- Fixation (eye), 394–395
- Force of habit, 161
- Forgetting, 325–333 (*see also* Memory; Retention)
- Formal discipline, 295
- Fovea, 376
- Fraternal twins, 67, 72
- Free association, 18, 258, 320, 338
- Frequency: in audition, 379; in learning, 305
- Frequency distribution, 57–59
- Frequency polygon, 57–59
- Frequency principle, 370–371
- Frigidity, 146
- Frontal lobe, 374–375
- Frustration, 199, 207–232; and aggression, 213; and goal orientation, 212; realistic reactions to, 213–214; severe, 211–213; tolerance, 212
- Fugue, 257
- Functional autonomy, 160–161
- Functional psychology, 12, 21
- Functional psychoses, 16, 260, 262–266
- Funiform papillae, 385
- Galvanic skin reflex (GSR), 182
- Gelb, Goldstein, Weigl, Scheerer Object Sorting Test, 353
- General adaptation syndrome (G.A.S.), 214
- General Clerical Test, 122
- General intelligence (*g*), 94
- Generalizing, 351–358
- General paresis, 261–262
- Genes, 66–67, 73
- Gestalt psychology, 24–25
- Gestures, 436, 451–452
- Gifted child, 94–98
- Glands, 145, 187, 239–241
- Glottis, 439
- Goal orientation, 212
- Gonads, 145, 239–241
- Goodenough Draw-a-Man Test, 108
- Graduate Record Examinations Aptitude Test, 118
- Graphic art aptitude, 132–133
- Gray matter, 372
- Gregariousness, 156
- Gross response, 39
- Group behavior (*see* Social behavior)
- Group dynamics, 466
- Group participation, effects, 474–477
- Group pressures, 477–481
- Group tests, 89, 91–94
- Group therapy, 259–260, 265
- Habit hierarchies, 291
- Habit interference, 292, 295–296
- Habits, 147, 161, 270
- Habitual attending, 398
- Hair cells, 380
- Hallucinations, 260, 320, 411
- Hammer, 379, 380
- Happiness, 200–201
- Healy puzzle box, 81, 288
- Hearing, 379–382; limits, 378
- Hebephrenic schizophrenia, 264
- Helicotrema, 380–381

- Heredity, 65-69, 70-76; effect on intelligence, 110-112
- Higher-order conditioning, 275
- Histogram, 58-59
- Holistic assessment, 243-244
- Holistic studies, 25
- Home influences on personality, 250-251, 252-253
- Homeostasis, 141-142, 216
- Hormones, 143, 145-146, 197-198, 240-241
- Horn Art Aptitude Inventory, 133
- Hue, 375
- Humor, 200
- Hunger, 142-144; as drive, 140
- Hydrocephalic, 99
- Hypnosis, 16-17, 162-163, 258, 398
- Hypothalamus, 187-188
- Hypotheses, 345; in concept formation, 355-357
- Hypothyroidism, 99-100
- Hysteria, 16-17, 257
- Id, 139, 162, 250
- Identical twins, 45, 67, 72, 83-84
- Identifying, 217, 464
- Idiot, 89, 99
- Illusions, 411-414
- Imbecile, 89, 99, 100
- Imitation, 290-291
- Implicit responses, 39
- Impotence, 146
- Imprinting, 457-459
- Inactivity, in forgetting, 327-328
- Incentives, 164
- Indecision, 255-256
- Independent variable, 40, 46
- Index of differentiation (ID), 169
- Individual, as concern of psychology, 15-19; status of, 61-62
- Individual differences, 8-9, 51-78; correlation, 62-65; distribution, 57-61; effect of environment, 69-76; effect of heredity, 65-76; measurement, 53-56; in mental growth, 103; statistical analysis, 56-65, 537-542
- Individual tests, 89
- Inferences, 345-346
- Information theory, 443-445
- Inhibition, 331-332
- Initiation of action, 229-230
- Insanity (*see* Psychoses)
- Insight, 289, 290, 293; in language, 435
- Inspiration, 361
- Instincts, 11, 147, 148, 154, 270
- Instructional sets, 402-403
- Instrumental conditioning, 274, 276-283
- Instrumentation learning, 289-290
- Insulin shock therapy, 265, 266
- Integration, 17
- Intelligence, 79-114, 233; age changes, 103-105; and aptitude, 117-119; effect of environment, 105-108; factors, 94; meaning, 79-84, 94; racial comparisons, 108-110; tests for animals, 79-80; tests for humans, 9, 80-81, 84-94
- Intelligence quotient (I.Q.), 85; changes, 102-103; distribution, 96 (*see also* Tests, intelligence)
- Intention, 230
- Interaction process analysis, 470-472
- Intercellular environment, 69
- Interests, 164-165, 233; and aptitudes, 119-122
- Internal environment, 69
- Internal set, 39
- Internal stimuli, 38-39
- Interpersonal relations, 466; methods of study, 466-473
- Interval scale, 55
- Interviews, 243-244
- Intracellular environment, 69
- Introspection, 7
- Introversion, 235-236
- Involuntary acts, 229
- Involuntary attending, 398
- Iris, 376
- Irradiation of excitation, 275
- Isolate, 468
- J-curve, 169
- James-Lange theory of emotion, 187
- Jealousy, 192, 202-203
- Job analysis, 129
- Joy, 192
- Just noticeable difference (j.n.d.), 409
- Kinesthesia, 365, 383-384
- Knowledge of results, 298-299
- Krause end bulbs, 387
- Kuder Preference Record, 120-122
- Laissez-faire leadership, 474
- Language, 430-455; origins, 436-438; statistical characteristics, 445; and thought, 349; in voluntary control, 230; word meaning, 447-450 (*see also* Speech)
- Larynx, 439
- Latent learning, 297, 304
- Laughter, 200
- Leadership, 471, 473-475, 485-486
- Learning, 8, 270-308; acquiring skills, 283-288; basic conditions for, 302-305; conditioning, 271-283; in emotional development, 193-194; foundations, 296; by imitation, 290-291; by insight, 289-290; of mazes, 283-285; problem-solving, 288-290; procedures comparison, 299-302; role of motivation, 296-299; speed, 322-323; work and rest periods, 299-302
- Learning ability (*see* Intelligence)
- Learning box, 328
- Learning curves, 284-285, 293, 297, 299, 300, 301
- Legends, 483
- Lens, 376
- Leptosome physique, 237-239
- Leveling, 482
- Level of aspiration, 159-160
- Level of confidence, 541
- Lie-detector, 182
- Life goals, 158-160
- Life space, 466-468
- Light, 375
- Light adaptation, 378
- Linear perspective, 419
- Linguistic ability, 117-118
- Locomotion, 466-468; in mice, 73-74
- Longitudinal studies, 103
- Lorge-Thorndike Intelligence Tests, 92-93
- Loudness, 379
- Love, 191, 201-202
- Maladjustment, 15-16, 255-266
- Mand, 442
- Mania, 262
- Manic-depressive psychosis, 262

- Manipulation need, 152–154
- Manipulatory aptitude tests, 123
- Manual dexterity tests, 123
- Massed learning, 301–302, 321–322
- Mass movement, 485
- Mastery motive, 156–157
- Matched groups, 45–46
- Materialism, 24
- Maternal drive, 140, 147–149
- Mating, 147
- Maturation in emotional development, 192–193
- Maze learning: animal, 11, 74–76, 79–80, 283–285; animal vs. human, 341–343; human, 284–285
- Mean, 47, 537; reliability, 540
- Meaning: and experience, 405–407; of words, 447–450
- Measurement, 37
- Mechanical aptitude, 122
- Median, 537–538
- Medical College Admissions Test, 118
- Meier Art Judgment Test, 132–133
- Meissner's corpuscles, 387
- Memorizing, 287
- Memory, 7–8, 309–336; growth with age, 31; and original learning, 321–325; recall, 315–321; recognition, 321, 322; training, 333–335
- Memory apparatus, 8
- Memory drum, 288
- Memory span tests, 315
- Memory trace, 310–311, 330–331
- Mental age (M.A.), 85
- Mental conflict, 212 (*see also* Conflict)
- Mental growth, 103–105
- Mental hygiene, 16, 266–267
- Mental illness, 15–18, 255–260, 346
- Mental retardation, 98–103
- Mental set, 393 (*see also* Set)
- Meprobamate, 260
- Mesmerism, 16
- Mesomorphy, 237–238
- Microcephalic, 98–99
- Migration, 457
- Minnesota Multiphasic Personality Inventory (MMPI), 247
- Minnesota Paper Form Board, 122
- Minnesota Rate of Manipulation Test, 123
- Mirth Response Test, 200
- Mob behavior, 483–485
- Mode, 60, 537
- Mongolianism, 99
- Moron, 89, 99, 101
- Mother machine, 150
- Motivation, 137–173; emotional, 174–206; in learning, 296–299, 304; personal-social, 154–160; physiological, 138–154; unconscious, 162–164
- Motivational sets, 403–405
- Motor cortex, 374
- Motor habit, reproducing, 311–312
- Motor impulses, 372
- Motor learning, 8
- Motor nerve fiber, 371
- Motor neuron, 368
- Motor skills, 271, 286; retention, 312; transfer, 292–293
- Motor theory of thinking, 350
- Müller-Lyer illusion, 411–412
- Multimodal distribution curve, 60
- Multiple-choice problems, 340–341
- Multiple personality, 257
- Muscle tension, 393, 396
- Musical aptitude, 132
- Mutations, 70
- Myelin, 369
- Naturalistic observation, 34–36
- Natural selection, 10
- Nazi movement, 485–486
- Needs, physiological, 138–141
- Negative correlation, 62–64
- Negative valence, 209
- Negro-white comparisons, 108–110
- Nerve, 369
- Nerve fibers, 368–369
- Nervous system, 368–375
- Nest-building drive, 140
- Neural circuit, 369
- Neural mechanisms in emotion, 187
- Neurasthenia, 255
- Neurogram, 310–311
- Neuron, 368
- Neuroses, 16–18, 255–260; experimental, 226–228
- Night blindness, 378
- Nine-dot problem, 347
- Noise, 379, 444
- Nonauditory labyrinth, 382–383
- Nondirective therapy, 258
- Nonhomeostatic drives, 149–154
- Nonsense syllables, 7, 287
- Nor-adrenalin, 241
- Normal distribution curve, 539
- Normal personality, 254–255
- Normal probability curve, 59–60
- Normative research, 14
- Nose, 384
- Nucleus, 65–66
- Nymphomania, 146
- Obliterating memory traces, 330–331
- Observational learning, 290
- Observer, 9
- Occipital cortex, 377
- Occipital lobes, 374
- Occupations, developing aptitude tests for, 128
- Oedipus complex, 203
- Olfactorium, 42
- Olfactory bulbs, 384
- Olfactory epithelium, 384
- Olfactory sensitivity, 384–385
- Only child, 253
- Onomatopoeia, 438
- Ontogenetic approach, 31
- Operant conditioning, 274, 276–282; in education, 282–283
- Operant conditioning box, 277–278
- Optic chiasma, 377
- Optic nerve, 370, 376–377
- Optic radiation, 377
- Ordinal scales, 54–55
- Ordinate, 57–58
- Organic psychoses, 16, 260–262
- Organic sense, 366
- Organic sensitivity, 386
- Organ of Corti, 380
- Otoliths, 383
- Oval window, 379, 380
- Ovary, 240
- Overcompensation, 221–222

- Overlapping distributions, 60–61
- Overlearning, 323–324
- Overt responses, 39
- Ovum, 65–66
- Pacinian corpuscles, 387
- Pain, 179–182
- Pain receptors, 386
- Papillae, 385
- Paranoid schizophrenia, 265
- Parasympathetic nervous system, 189–190
- Parathyroid glands, 240
- Parent, in personality development, 250–253
- Paresis, 261–262
- Parietal lobes, 373
- Pecking order, 460
- Pencil-and-paper aptitude tests, 122
- Perceiving, 7, 391–429; analysis, 400–402; auditory space, 423–425; clearness, 393, 396–397; context, 407–409; of differences, 409–410; effect of experience, 405–407; primitive organization, 410–415; reduced cues, 407; set in, 402–405; visual depth and distance, 415–423
- Percentiles, 61–62, 539
- Perceptual constancy, 414–415
- Perceptual curiosity, 152
- Performance tests, 89–91
- Peripheral nervous system, 368
- Peripheral theory of thinking, 350
- Perseveration, 361
- Persistence, 228–229
- Personal equation, 8
- Personality, 233–269; assessment, 242–248; development, 248–252; and endocrine glands, 239–242; normal, 254–255; and physique, 236–239; prevention of disorders, 266–267; psychoneurotic, 255–260; psychopathic, 251; psychotic, 260–266; situational influences, 252–254; traits, 233–235; types, 235–239
- Personal motives, 157–160
- Personal-social motives, 154–160
- Personal-social needs, 139
- Perspective, 419; auditory, 425
- Phenylpyruvic feeble-mindedness, 101
- Phi-phenomenon, 413
- Phobias, 162, 257
- Phylogenetic approach, 31
- Physiological aspects of feelings and emotions, 182–186
- Physiological drives, 138–154
- Physiological limit, 284
- Physiological needs, 138–154
- Physique, and temperament, 236–239
- Pitch, 379
- Pituitary gland, 187, 239–241
- Placebo, 39
- Place theory, 381–382
- Plateau, 285
- Play therapy, 267
- Pleasure principle, 179–182
- Polydactyly, 70
- Population mean, 540
- Positive correlation, 62–64
- Positive valence, 209
- Post-hypnotic suggestion, 162–163
- Postural adjustment in attending, 393, 395–396
- Preconscious, 162
- Prejudices, 165–166
- Prenatal external environment, 70
- Pressure receptors, 387
- Primary traits, 234
- Proactive inhibition, 331–332
- Probability distribution, 59
- Probability in language, 445
- Problem boxes, 288–289
- Problem-solving, 271, 288–290; individual and group, 471–473
- Product-moment method, 541
- Projection, 222–223
- Projective tests of personality, 244–246
- Prolactin, 197–198
- Propagated disturbance, 369
- Psychiatry, 19–20
- Psychoanalysis, 14–15, 17, 25, 258, 265
- Psychodrama, 259
- Psychology: abnormal, 15–19, 98–103, 251, 255–266; animal, 10–13, 34–37; child, 13–15, 32–34; clinical, 15, 19–20, 32; history, 3–27; scope, 5–9; social, 34, 456–488; systems of 20–26
- Psychoneuroses, 255–260 (*see also* Neuroses)
- Psychopathic personalities, 251
- Psychophysics, 409–410
- Psychoses, 15–16, 260–266
- Psychosomatic medicine, 216
- Psychosurgery, 266
- Psychotherapy, 258–260, 265
- Puberty praecox, 241
- Pupil, 376
- Pursuit tracking, 286
- Puzzle boxes, 81
- Pyknic physique, 237
- Quantitative ability, 117–118
- r*, 63–65
- Racial comparisons of intelligence, 108–110
- Rage, 191
- Range, 61, 538
- Rank-difference method, 542
- Rank standing, 61–62
- Rational elaboration of ideas, 346
- Rationalization, 223
- Ratio scales, 53
- Reactive inhibition, 302
- Reality testing, 153, 250
- Reasoning, 338; in animals, 339–343; evidence for, 339–343; process, 344–349; test, 339 (*see also* Thinking)
- Recall, 338; of narratives, 316–318; of paired associates, 316–321; stimuli in, 320; verbal, 315–316 (*see also* Memory)
- Recapitulation, 14
- Receptors, 187; auditory, 379–382; cutaneous, 386–387; kinesthetic, 383–384; olfactory, 384–385; organic, 386; static, 382–383; taste, 384–385; visual, 375–378
- Receptor processes: in attending, 393–395; in perceiving, 400
- Recessive gene, 73
- Reciprocal stimulation and response (*see* Social behavior)
- Recitation, 302, 322, 323
- Recognizing, 321, 322
- Redintegration, 321, 407
- Reduced cues, 320, 321, 407
- Redundancy, 446–447
- Reflex, 138, 147, 270, 272

- Reflex arc, 368, 369, 372
- Reflex circle concept, 441
- Refractory period, 370–371
- Regression, 223–225
- Reinforcement, 273, 276; in learning, 296, 304–305; primary and secondary, 280–281; schedules, 279
- Reissner's membrane, 380
- Relative refractory period, 370
- Relearning, 312
- Reliability: of difference between means, 540–541; of mean, 540; of measurements, 55–56
- Reliability coefficient, 55–56
- Remembering (*see* Memory)
- Reminiscence, 324–325
- Repetition, in learning, 304–305
- Repression, 225–226
- Repressive forgetting, 328–329
- Reproduction of forms, 318
- Resistance in stress, 214
- Response, 38–39
- Response-response relationships, 47–48
- Rest and work periods, 299–302
- Retardation, 98–103
- Retention: nonverbal evidence, 311–312; and original learning, 321–325 (*see also* Memory)
- Reticular formation, 187–188, 372–373, 397
- Retina, 375–377
- Retinal disparity, 422
- Retroactive inhibition, 331–333
- Retrograde amnesia, 326, 329
- Reverberating circuits, 373
- Reverie, 338
- Reversible configurations, 397–398
- Revolving drum apparatus, 140
- Rewards in animal learning, 296–297
- Reward training, 278
- Rho ( $\rho$ ), 542
- Rods, 375–377
- Role, 464–465
- Rorschach test, 245–246
- Round window, 379, 380
- R–R relationships, 47–48
- Ruffinian cyclinders, 387
- Rumor, 481–483
- Sacculi, 382–383
- Salivary response, 272–273
- Saturation of colors, 375
- Satyriasis, 146
- Saving method, 312
- Scatter diagrams, 63
- Schizophrenia, 260–261, 263
- Scholastic aptitude, 117–118, 125
- Science, nature of, 4–5
- Scientific method, 4–5, 29–32
- Sclerotic coat, 376
- Seashore Tests of Musical Talent, 132
- Self, 250, 464
- Self-assertive motive, 156–157
- Self-repudiation, 221–222
- Semantic differential, 449–450
- Semantics, 448–450
- Semicircular canal, 379, 382–383
- Senile psychoses, 262
- Sensations, 6, 7 (*see also* Receptor processes; Sensitivity)
- Sense organs (*see* Receptors)
- Sensitivity, 366–369
- Sensorimotor skills, 283
- Sensory impulses, 372
- Sensory nerve fiber, 371
- Sensory neuron, 368
- Sensory stimuli, 38, 366
- Serendipity, 361
- Set: and attending, 392–393; control of, 39, 43–45; and experience, 405; in perceiving, 402–405; in reasoning, 338
- Sex drive, 140, 145–147
- Sharpening, 482
- Shock therapy, 262, 265, 266
- Siamese twins, 67
- Sigma ( $\sigma$ ), 538
- Significant differences, 541
- Simple recall, 287
- Simple schizophrenia, 263
- Skewed curve, 60
- Skills, 271; acquiring, 283–288 (*see also* Motor skills; Verbal skills)
- Skin senses, 386–387
- Sleep, in forgetting, 327
- Smelling, 384–385
- Smiling, 200
- Social behavior, 34, 456–488; elementary forms, 457–461; large groups, 483–486; methods of study with small groups, 465–473
- Social climates, 474–475
- Social environment, 466
- Social facilitation, 461–462
- Social field, 466–468
- Social heritage, 70
- Social intelligence test, 200
- Socialization, 457–460
- Social motives, 156–157
- Social movements, 485–486
- Social status, 460, 463–465
- Sociogram, 468–469
- Sociometric procedures, 468–470
- Sociometric questionnaire, 244
- Somaesthetic receptors, 373 (*see also* Kinesthesia)
- Somatonia, 238
- Somatotype, 237–239
- Sour-grapes reaction, 223
- Space perception: auditory, 423–425; intersensory, 425–426; visual, 415–423
- Spatial maze, 342
- Specific ability ( $s$ ), 94
- Speech: development in child, 287, 440–443; mechanisms, 438–440; symbols, 430 (*see also* Language)
- Spinal cord, 187, 371–372
- Spinal nerves, 371
- Split-litter control, 45
- Spontaneous recovery, 275
- Standard deviation, 538–539
- Standard error: of difference between means, 540; of mean, 540
- Standard score, 62, 538–539
- Stanford-Binet intelligence tests, 86–89, 91
- Star, 468
- Startle pattern, 181
- Static sense, 365
- Static sensitivity, 382–383
- Statistical analysis, 46–48, 56–65, 537–542
- Status, 460, 463–465
- Stereophonic effects, 425
- Stereoscopy, 422
- Stimulation drives, 149–154
- Stimulation need, 151–152

- Stimulus, 6, 38, 366  
 Stimulus generalization, 275  
 Stirrup, 379, 380  
 Stress, 214 (*see also* Anxiety; Conflict; Frustration)  
 Stress interview, 243–244  
 Strong Vocational Interest Blank, 120  
 Structural psychology, 21  
 Stylus maze, 284–285, 341–342  
 Subconscious, 162  
 Subject, 9  
 Sublimation, 219  
 Subliminal advertising, 400  
 Superego, 139, 162, 250–252  
 Surface traits, 234  
 Survival of the fittest, 10  
 Suspensory ligaments, 376  
 Symbolic process, 313–314, 431, 435; in perceiving, 400–401 (*see also* Thinking)  
 Symbols, 337  
 Sympathetic nervous system, 189–190  
 Sympathy, 203–204  
 Synapse, 368  
 Syndrome, 214
- Tabes dorsalis, 384  
*Tabula rasa*, 19  
 Tachistoscope, 402  
 Tact, 442  
 Taste buds, 385  
 Taste receptors, 385  
 Taste sensitivity, 384–385  
 Taylor Scale of Manifest Anxiety, 198  
 Teaching machine, 282  
 Tectorial membrane, 380  
 Temperament, and physique, 236–239  
 Temperature drive, 140  
 Temperature receptors, 387  
 Temporal lobes, 374, 381  
 Temporal maze, 341–342  
 Tensor tympani, 380  
 Testimony, 318–319  
 \*Tests, 240  
 Tests: aptitude, 54, 122–123; group, 91–94; individual, 89; intelligence, 9, 79–81, 84–94; personality, 242–248; Rorschach, 245–246  
 Thalamus, 187, 372, 377, 381  
 Thematic apperception, 217, 246  
 Thematic Apperception Test (T.A.T.), 246  
 Thinking, 337–364; creative, 358–362; and language, 349; theories of, 349–350 (*see also* Reasoning)  
 Thinking machines, 343–344  
 Thirst, 144  
 Thyroid gland, 239–241  
 Thyroxin, 241  
 Timbre, 379  
 Time, in forgetting, 327  
 Tone, 379  
 Tongue, 385  
 Tracking, 286, 299  
 Traits, 53, 233–235 (*see also* Individual differences; Personality)  
 Tranquilizers, 260, 262–263, 265–266  
 Transfer of learning, 292–296  
 Trial and error, 283, 284, 288–290, 293; in concept formation, 355  
 Tropisms, 138, 270  
 True mean, 540
- T-score, 539  
 Twins, 67, 72–73, 83–84  
 Tympanic canal, 380  
 Tympanic membrane, 380
- Ulcers, 215–216  
 Uncertainty, in information theory, 444–445  
 Unconditioned reflex, 272  
 Unconditioned stimulus, 272  
 Unconscious, 17–18, 162  
 Unconscious motivation, 162–164  
 Unconscious traits, 234  
 USES aptitude test, 127  
 Utricle, 382–383
- Valences, 209  
 Validity, 128–129  
 Variability, 61, 538  
 Variables, 40  
 Vector psychology, 209  
 Ventral root, 371  
 Verbal ability, 117–118  
 Verbal learning, 8  
 Verbal recall, 315–316  
 Verbal reports, 32  
 Verbal skills, 271, 283, 287; retention, 312; transfer, 293–294 (*see also* Memory)  
 Verbal tests, 89  
 Vestibular branch, 379, 383  
 Vestibular canal, 380  
 Vestibule, 382–383  
 Vigotsky Test of Conceptual Thinking, 354  
 Viscera, 187  
 Viscerotonics, 238  
 Vision: brain in, 373–374; depth and distance, 415–423; reception, 375–378; stimuli, 366  
 Visual purple, 378  
 Vitreous body, 376  
 Vocal cords, 438–439  
 Vocational guidance, 116, 134 (*see also* Aptitude)  
 Vocational selection, 116, 134–135 (*see also* Aptitude)  
 Volley theory, 382  
 Voluntary acts, 229–230  
 Voluntary attending, 398
- Warden Y-maze, 284  
 Weber's law, 6, 409–410  
 Wechsler Adult Intelligence Scale (WAIS), 89–90  
 Wechsler-Bellevue intelligence scale, 89  
 Wechsler Intelligence Scale for Children (WISC), 89–90  
 White matter, 372  
 "Will power," 228–229  
 Will to power, 159  
 Withdrawal, 263  
 Words: acquiring, 441–442; meaning, 447–450  
 Work and rest periods, 299–302  
 Worry (*see* Anxiety)  
 Written language, 437–438
- Yerkes Multiple-Choice Problem, 340  
 Young's pseudophone, 425
- Zero correlation, 62  
 Z-score, 539













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